DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-262

TO 16-35-C292-6

CONTROL UNITS

C-292/TRA-7

C-292A/TRA-7

AND C-292B/TRA-7

DEPARTMENTS OF THE ARMY AND THE AIR FORCE • APRIL 1952

TM 11-262/TO 16-35-C292-6

This manual supersedes so much of TM 11–278, 23 October 1946, including C1, 12 November 1947; C2, 14 April 1948; and C3, 17 February 1949, as pertains to control units C–292/TRA–7 and C–292A/TRA–7.

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AND C-292B/TRA-7

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DEPARTMENTS OF THE ARMY AND
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For explanation of distribution formula, see SR 310–90–1.

CONTENTS

SAFETY NOTICE

Voltages as high as 890 volts are used in the operation of this equipment. These voltages are dangerous to life.

There are interlocks in this set. A few service checks must be made inside the set during trouble shooting, with the power supply in operation. When making these checks, always have present another person capable of rendering first aid. Keep one hand in your pocket while making high-voltage measurements. This precaution will prevent your touching the electrical circuit with more than one part of the body at one time.

Teletypewriter lines are not dangerous but will give a painful shock.

It is advisable to turn off the transmitter before removing the control unit from the circuit.

First Aid for Electric Shock

RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only,* remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

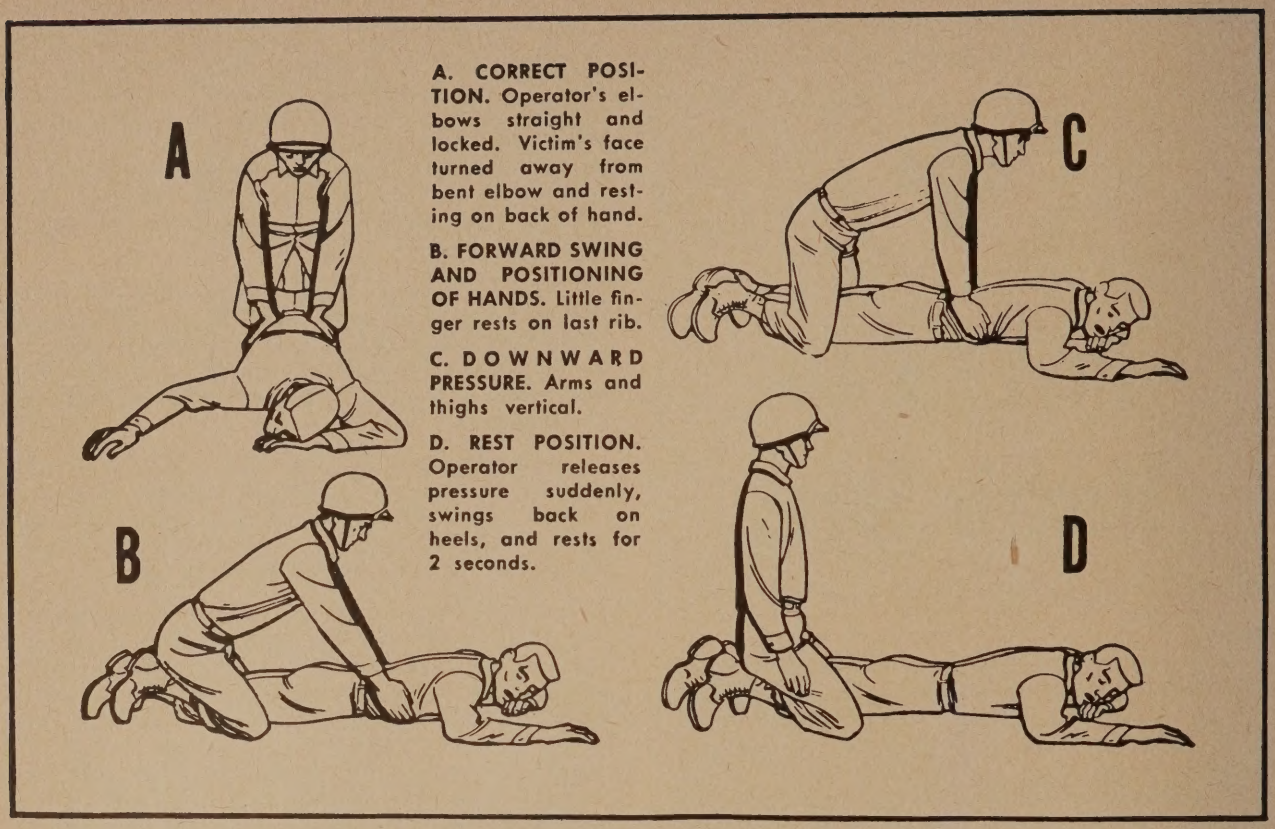
f. The resuscitation procedure is as follows:

(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit up on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4



A. CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.

B. FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.

C. DOWNWARD PRESSURE. Arms and thighs vertical.

D. REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

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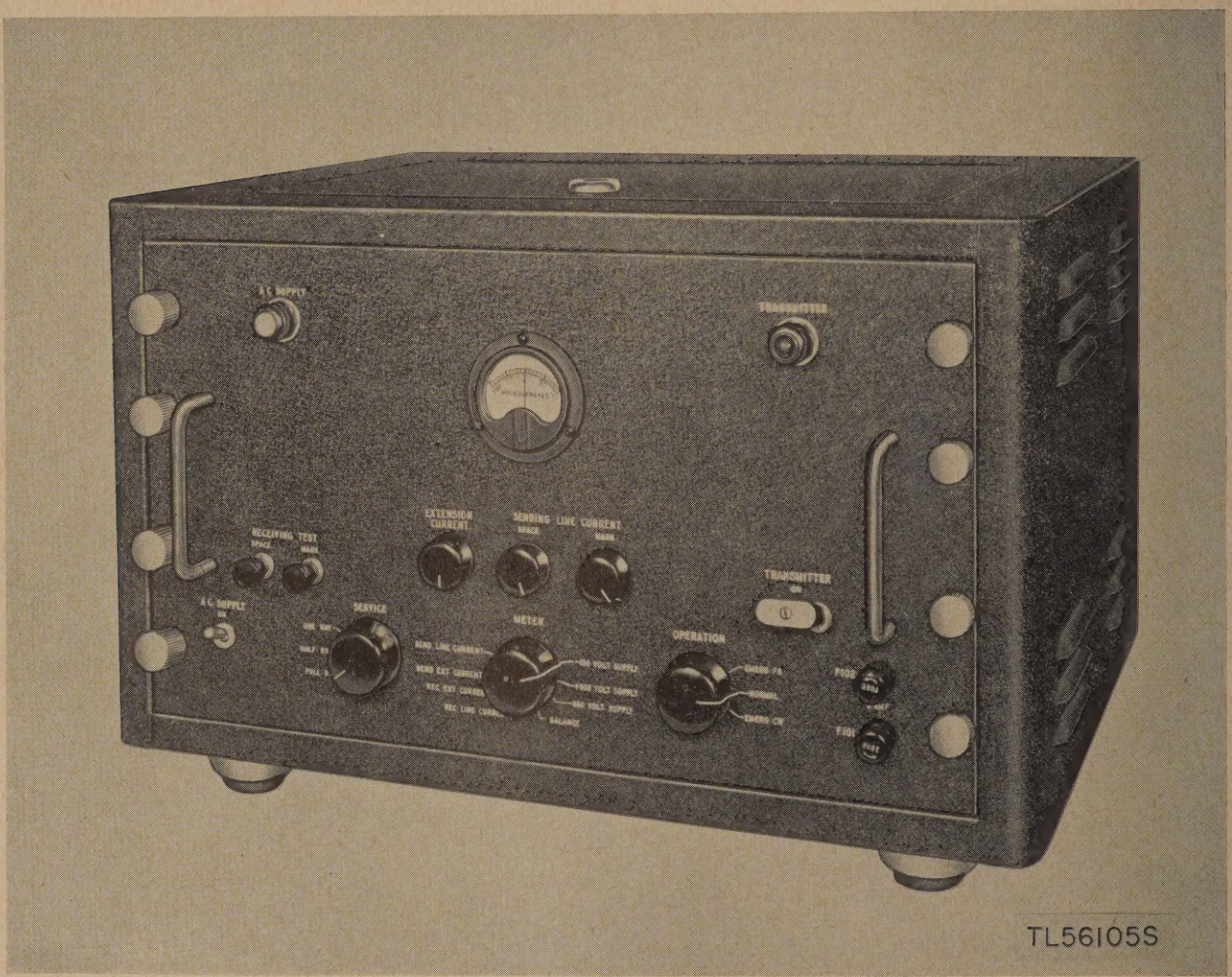


Figure 1. Control Unit C–292/TRA–7.

This manual supersedes so much of TM 11–278, 23 October 1946, including C1, 12 November 1947; C2, 14 April 1948; and C3, 17 February 1949, as pertains to Control Units C–292/TRA–7 and C–292A/TRA–7.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This technical manual contains a description of Control Unit C–292(*)/TRA–7 (fig. 1) and its operating controls, a chapter on theory of operation, and instructions for field maintenance and repair of the equipment. In addition, this manual includes two appendixes covering a list of references and an identification table of parts.

b. Since the control unit normally is installed in one of several different systems, installation and operation instructions are omitted from this manual and are included in the technical manuals covering the particular system. Specialized organizational maintenance information, such as techniques for isolating trouble to the particular system unit, are also omitted from this manual and included in the various systems manuals.

c. Official nomenclature followed by (*) is used to indicate the unlettered, A, and B models of the item of equipment described in this manual.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army matériel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), NAV DEPT SERIAL 85P00 (Navy), and AFR 71–4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. AF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Matériel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AFR 65–26.

d. DA AGO Form 11–238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

e. DA AGO Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

f. Use other forms and records as authorized.

Sestion II. DESCRIPTION AND DATA

3. Purpose and Use

Note. For an explanation of the teletypewriter terms and phrases used, refer to paragraphs 19–27 and TM 11–680.

a. Control Unit C–292(*)/TRA–7 is an electronic repeater unit of polar and neutral teletypewriter signals. The control unit converts polar telegraph signals received from a dual-diversity converter into neutral signals for operating a receiving teletypewriter. The control unit also translates neutral signals from a sending teletypewriter into polar signals for

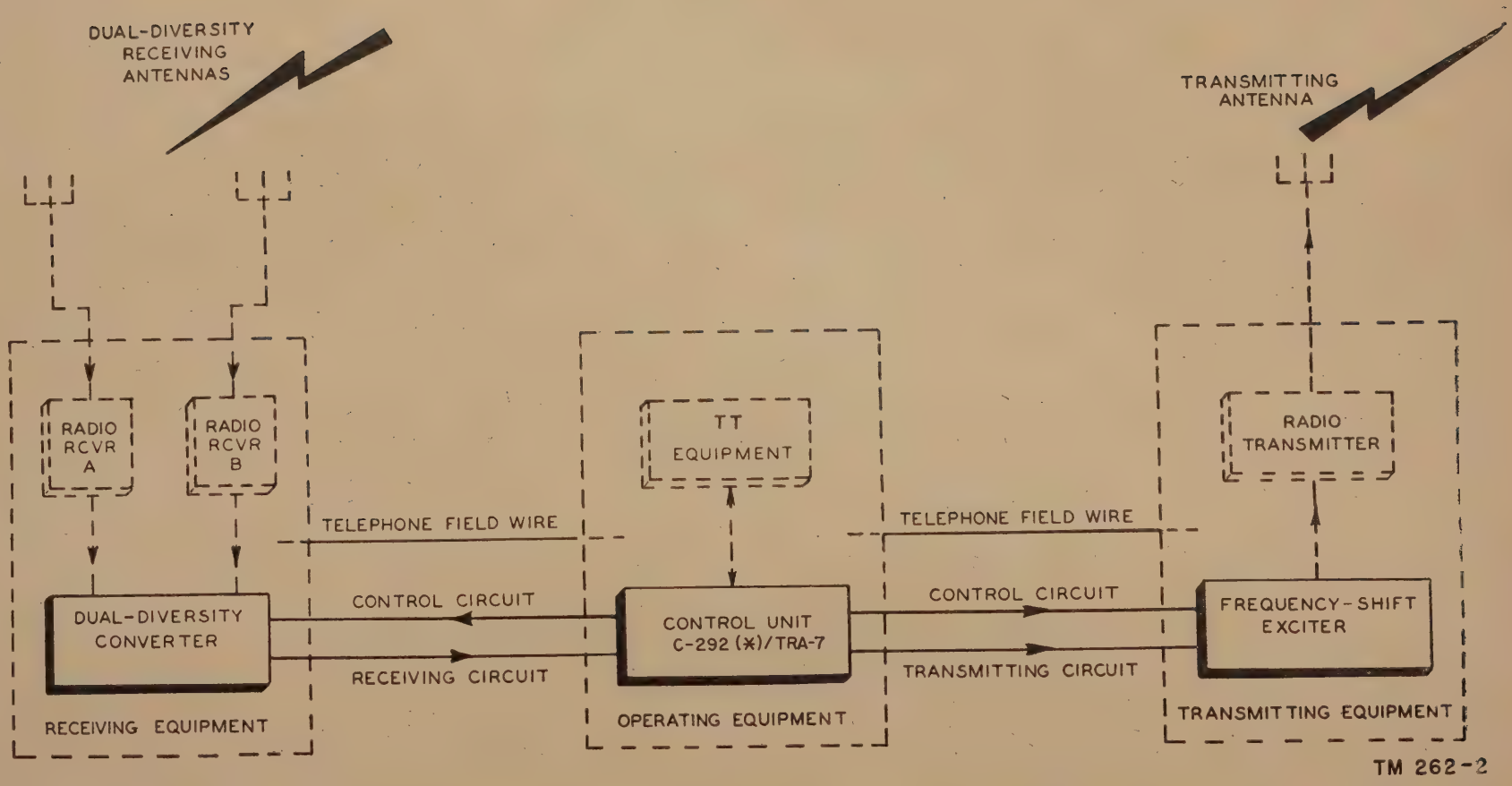


Figure 2. Block diagram of components comprising one terminal of radioteletype equipment

transmission over a wire line to control a frequency-shift exciter.

b. The control unit contains an integral power supply. The power supply furnishes power for all internal functions and line current for TT (teletypewriter) extension circuits.

c. The control unit, together with other equipment (par. 4), provides facilities for establishing RTT (radioteletype) full-duplex, half-duplex, one-way reversible, or emergency c-w (continuous-wave) transmission and reception.

4. System Application

a. Control Unit C–292(*)/TRA–7 is one component of RTT equipments which comprise a medium or high-powered, mobile radioteletype terminal. Two RTT terminals operating together provide full-duplex, half-duplex, or one-way reversible teletypewriter operation. Emergency FS (frequency-shift) or c-w code operation is also possible with these systems of which the control unit is a part.

b. Figure 2 is a block diagram showing the relationship between the receiving equipment, the operating equipment, and the transmitting equipment located at one type of radioteletype terminal. These equipments may be in three separate shelters, as in Radio Set AN/MRC–2, or in one shelter, as in Radio Set AN/GRC–26.

(1) The receiving equipment consists of two radio receivers and a dual-diversity converter. Each receiver has its own antenna; these antennas are normally spaced several wavelengths apart. Such a system of space diversity reception reduces the effects of selective fading. The output of each receiver is applied to the dual-diversity converter, which combines the received frequency-shifted signals and converts the stronger receiver output into d-c (direct-current) neutral and polar signals. The neutral signals operate the printing mechanism of the monitoring teletypewriter in the receiving shelter, and the polar signals may be sent over land lines to an operating shelter.

(2) The operating shelter contains the control unit and teletypewriter equipment on which messages are received and transmitted. The control unit receives the polar signals from the dual-diversity converter and produces neutral signals which operate the receiving TT printers. The control unit also receives neutral signals from the sending contacts of the teletypewriters and produces polar signals which are sent over a land line to key the frequency-shift exciter in the transmitting shelter. For one-way reversible operation where transmission occurs in only one direction at a time, hand-operated key control is provided through the control unit to permit the operator to disable the transmitter while receiving and to disable the receiver when transmitting. The control unit is also designed to provide for emergency hand-keying of the FS exciter (frequency-shift or c-w signals) form the operating shelter.

(3) The transmitting shelter contains the FS exciter and the radio transmitter which it excites and controls. The polar signals from the control unit in the operating shelter are applied to the FS exciter. The nominal carrier frequency to which the transmitter is set is that produced by the marking signal. When a spacing signal is received from the control unit, the exciter signal frequency is lowered sufficiently to reduce the transmitter carrier by 850 cycles. (With l-f (low-frequency) transmitters, the shift is normally 170 cycles.) The transmitter signal is radiated from the antenna connected to the transmitting shelter.

c. When not used in a specific system, Control Unit C–292(*)/TRA–7 may be located at the receiving station, the transmitting station, or any desired location within 10 miles of the two.

5. Technical Characteristics

Receiving circuit, polar input signals:
Mark .....+.025 ampere.

Space .....—.025 ampere.
Sending circuit, polar output signals:
Mark .....+.020 ampere.
Space .....—.025 ampere.
TT extension circuit signals:
Mark ..... .060 ampere.
Space ..... .0 ampere.
Number of tubes .....15 (16 in B model).
Power:
Input .....115 volts, 50 to 60 cycles.
Consumption .....170 watts.
Weight .....100 pounds.

6. Description

The control unit is inclosed in a black, crackle-finish, metal cabinet equipped with a hinged access door in the top. The standard cabinet is 12¼ inches high, 16⅞ inches deep, and 21½ inches long. The cabinet is mounted on four shock mounts to protect the equipment from the ordinary shock and vibration of transportation. The control unit chassis and front panel slides into the cabinet on guide rails. The chassis can be partly withdrawn from the cabinet on the guide rails in order to permit replacement of tubes or minor adjustments. In addition, the chassis can be removed from the guide rails and pulled completely out of the cabinet without removing the external connections which are made to the jacks on the rear of the unit (fig. 3). All operating controls are mounted on the front panel and the unit is held in place by eight knurled thumbscrews which secure the front panel to the sheetmetal cabinet.

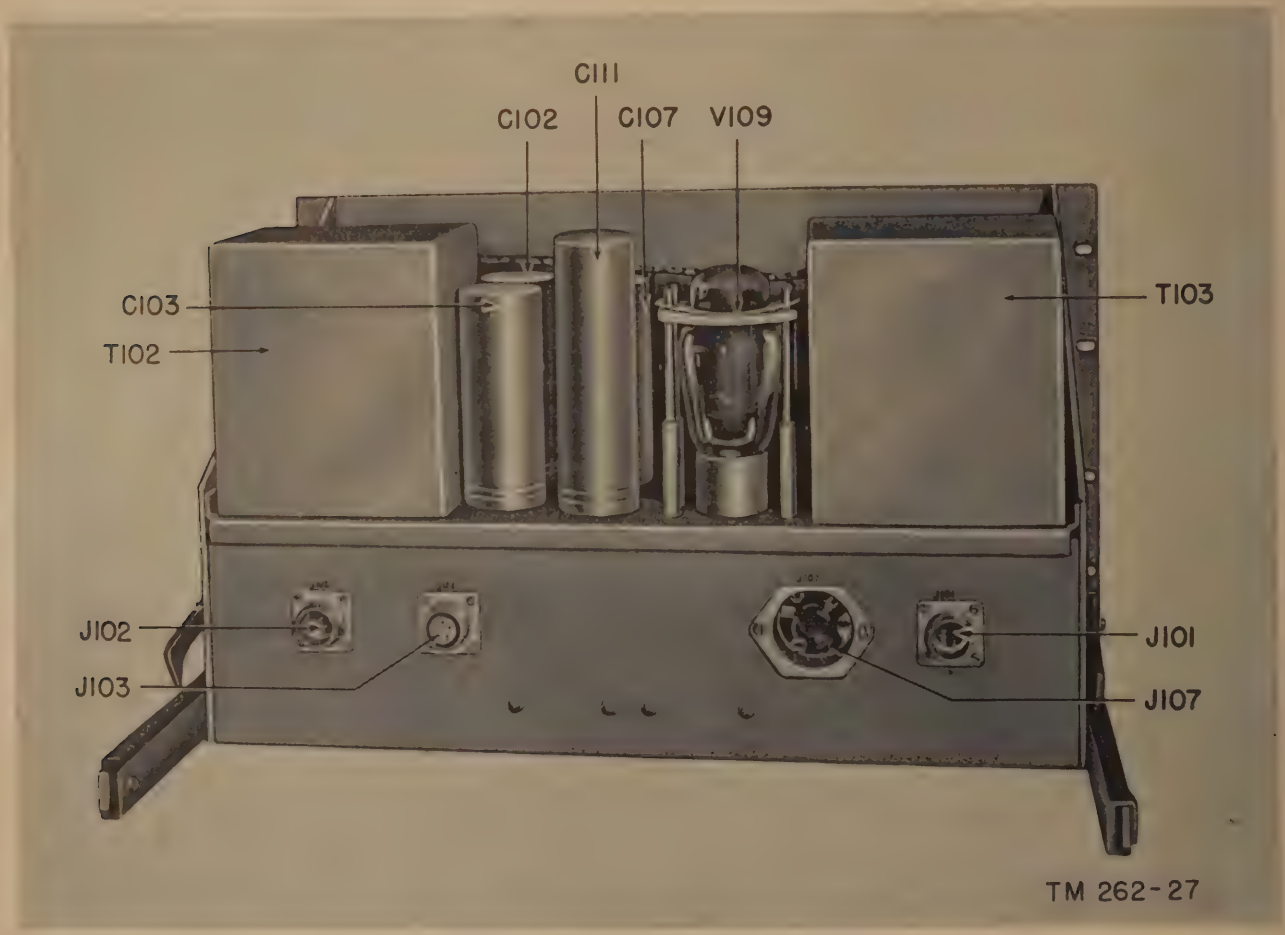


Figure 3. Rear view of control unit.

7. Differences in Models

a. The A model differs from the unlettered model equipments in the following respects:

(1) Some components in the equipment have been replaced with JAN components.

(2) The color coding used in wiring the control unit has been changed. Changes are shown in figures 36 through 38.
(3) Different sized terminal boards are used.
(4) The magnetic-vane type meter is replaced by a meter using a moving-coil movement.
(5) Filament series resistor R188 is not used.

b. Control Unit C–292B/TRA–7 differs from the A model in the following ways:

(1) Voltage regulator varistor R187 has been replaced by voltage regulator tube V117 (a type OC3) and three resistors, R189, R190, and R191 (figs. 24 and 34). Tube V117 has been mounted in the approximate location of the varistor which it replaces.
(2) The mounting dimensions of transformer T103 have been changed.
(3) The control unit is mounted in a special cabinet when used in Radio Set AN/GRC–26. The outside dimensions of the cabinet are—19⅛ inches wide by 12-15/16 inches deep by 11-27/32 inches high.
(4) Filament resistor R188 is used in this model.

8. Stage Name Changes

Many early diagrams of Control Units C–292(*)/TRA–7 do not show stage names. Others have stage names that are not indicative of the actual function of the tube in that stage. All stages are referred to uniformly throughout this manual by the title listed in column two below. Column three lists stage function names that have been used previously.

Stage	Function	Alternative stage titles
V101	Mark-space switching.	Electronic switching circuit.
V102	Mark-space limiting...	Peak clipper.
V102A	Mark limiting.	
V102B	Space limiting.	
V103	Mark-space locking...	Electronic switching circuit.
V104	Receive extension driving.	External current amplifier.
V105	Polar mark driving	Polar mark amplifier.
V106	Polar space driving....	Polar space amplifier.
V107	Neutral send keying...	Drive amplifier.
V108	+300 volt rectifier.....	+300 volt rectifier.
V109	—150 volt rectifier.....	—150 volt rectifier.
V110	—300 volt rectifier.....	—300 volt rectifier.
V111	+300 volt regulator...	+300 volt regulator
V112	—150 volt regulator....	—150 volt regulator.
V113	—150 volt regulator...	—150 volt regulator.
V114	+300 volt control.....	+300 volt control.
V115	—150 volt control.....	—150 volt control.
V116	—300 volt regulator...	—150 volt regulator.
V117	Voltage reference.....	105 volt regulator.

Section III. CONTROLS AND INSTRUMENTS

9. General

Haphazard operation or improper setting of the controls can cause damage to electronic equipment. For this reason it is important to know the function of every control. Operating controls of the control unit are mounted on the front panel (fig. 4). Additional screwdriver controls for preoperational adjustments are located inside the cabinet on the control unit chassis (fig. 5). Connection receptacles are mounted on the rear (fig. 3).

10. Controls

The following table lists the controls and their functions.

Control	Function
F101 and F102 3 AMP fuses.	In leads of primary a-c (alternating-current) power supply, to protect power transformer against overload caused by internal short.
AC SUPPLY switch (S108).	Connects 115-volt, 60-cycle power to the control unit.
AC SUPPLY indicator lamp (I102) (white).	Lights up when AC SUPPLY switch is thrown to ON position and power is applied to control unit.
RECEIVING TEST switches SPACE (S101)	Permit operator to test and adjust receiving circuit in the control unit. When SPACE

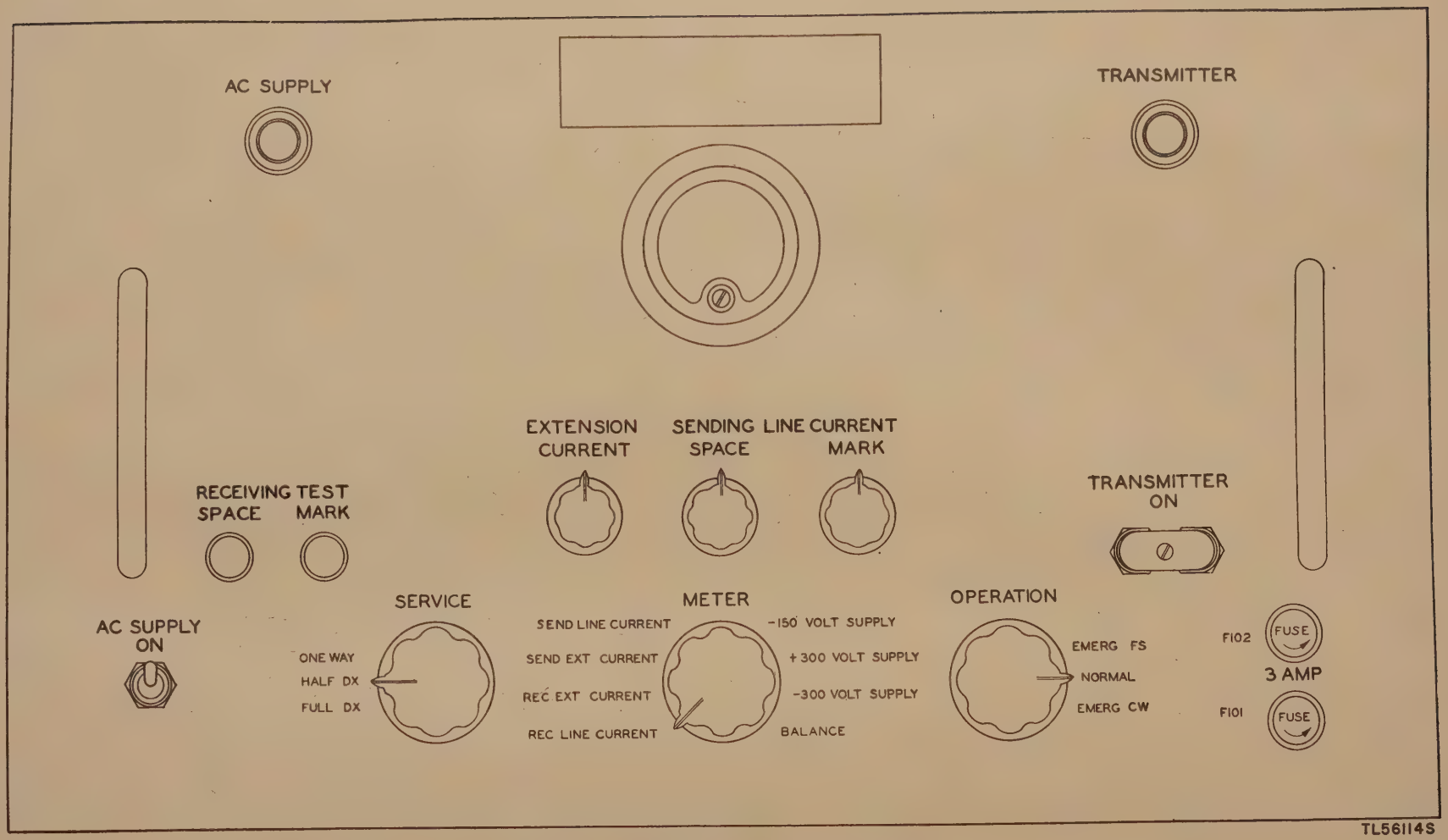


Figure 4. Location of front panel controls.

Control	Function
MARK (S103)	push button is depressed, a steady space signal is transmitted through receiving circuit of control unit. When MARK push button is depressed, a steady mark signal is transmitted through the receiving circuit.
SERVICE switch (S102)	Determines mode of operation of control unit. When used for one-way reversible operation, the switch is set at ONE-WAY. When used for half-duplex or full-duplex operation, the switch is set at HALF DX (duplex) or FULL DX, respectively.
METER switch (S105) and meter (M101).	Eight-position switch connects the front panel meter to circuits indicated by the following switch settings:
	Position — *Function*
	REC LINE CURRENT — Gives relative indication of polar input current from dual-diversity converter; between A and B of J101.
	REC EXT-CURRENT — Gives re'ative indication of neutral receiving loop extension current during FULL DX operation.
	SEND EXT-CURRENT — Gives relative indication of neutral 60 ma (milliamperes) loop extension current.
	SEND LINE CURRENT — Gives relative indication of polar output loop current at A and B of J102.

Control	Function
	Position — *Function*
	—150 VOLT SUPPLY — Indicates output of —150-volt section of power supply.
	+300 VOLT SUPPLY — Indicates output of +300-volt supply at V111 cathode.
	—300 VOLT SUPPLY — Indicates output of —300-volt supply.
	BALANCE — Used with BALANCE ADJUST R126 to allow incoming mark and space signals to have equal effect on V101.
OPERATION switch (S104)	OPERATION switch is set at NORMAL (mid-position for normal radioteletype operation. For c-w hand keying, the OPERATION switch is set to EMERG CW. For frequency-shift hand keying, the OPERATION switch is set to EMERG FS.
EXTENSION CURRENT control (R110)	Adjusts teletypewriter receiving loop current (REC EXT-CURRENT meter reading) for full-duplex operation. Adjusts teletypewriter sending loop current (SEND EXT-CURRENT meter reading) fo half-duplex or one-way reversible operation.
SENDING LINE CURRENT controls SPACE (R143) MARK (R146)	SPACE control adjusts spacing signal current in transmitting loop to frequency-shift exciter. MARK control adjusts mark signal current in transmitting loop to frequency-shift exciter.
TRANSMITTER switch (S109 and S110)	Controls radio transmitter from control unit location. Throwing TRANSMITTER switch

Control	Function
	to ON operates relay in frequency-shift exciter, which keys exciter and causes transmitter to produce a signal. For one-way reversible operation, throwing TRANSMITTER switch to ON also operates a relay in the dual-diversity converter unit, disabling the radio receivers.
TRANSMITTER indicator lamp (I101) (green).	Lights when TRANSMITTER switch is in ON position.
BALANCE ADJ screw driver control (R126) (fig. 5).	Provides a means of balancing mark and space potentials in the input circuits of the control unit receiving section.
—150V ADJ screw driver control (R181) (fig. 5)	Adjusts output voltage of —150-volt regulated supply.
+300V ADJ screw driver control (R172) (fig. 5).	Adjusts output voltage of +300-volt regulated supply.
Input connector (J101) (fig. 3).	Connects control unit to dual diversity converter.
Output connector (J102) (fig. 3).	Connects control unit to frequency shift exciter.
Extension connector (J103) (fig. 3).	Connects control unit to teletypewriters.
Power input jack (J107) (fig. 3).	Input connection for 110-volt a-c power.

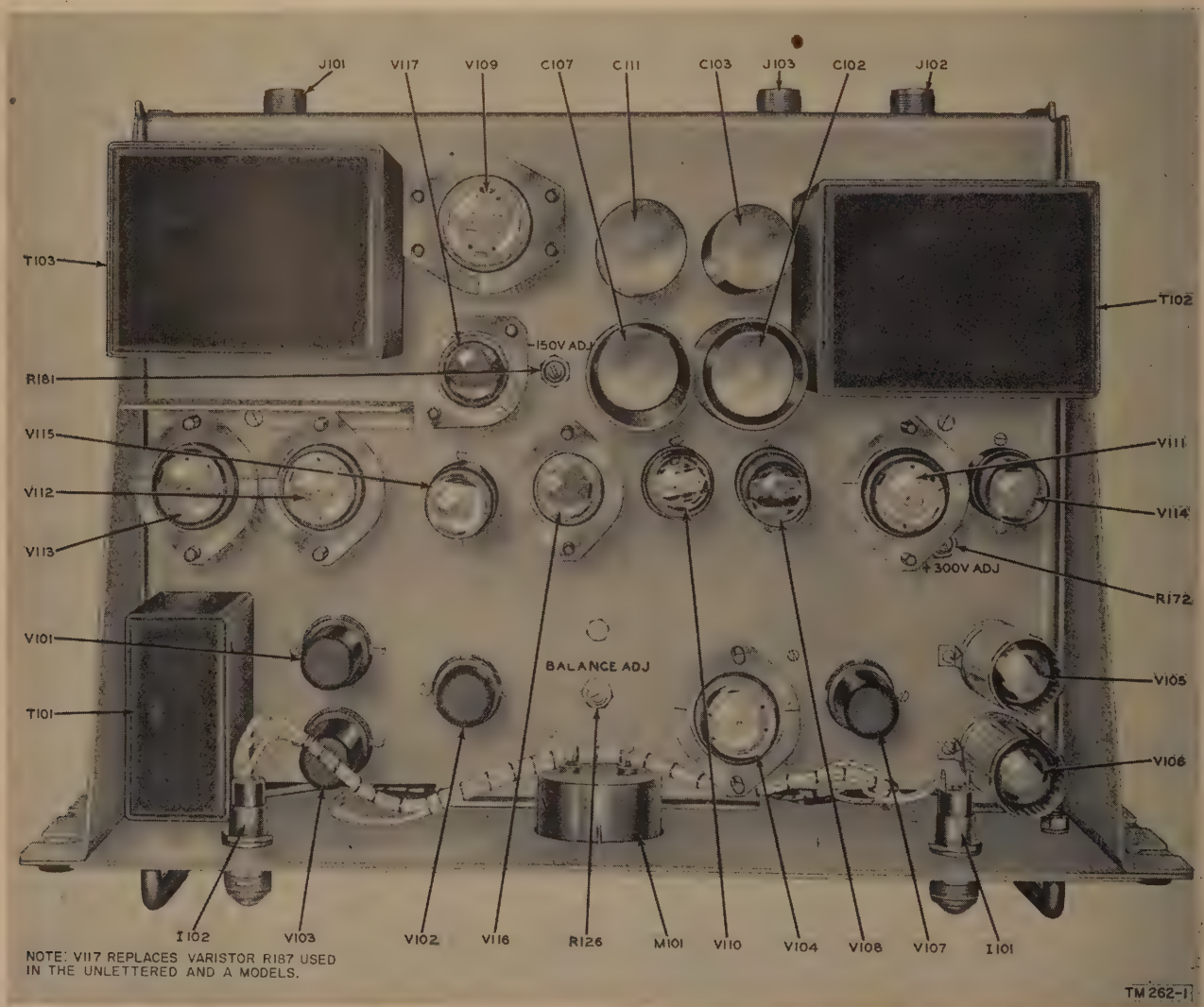


Figure 5. Top view of chassis.

CHAPTER 2

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

11. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in such good working order that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring.

12. Organizational Tools and Equipment

Tools and materials that should be available at the organizational level are listed in *a* and *b* below. The pertinent tool kit is listed in Department of the Army Supply Catalog SIG 6–TE–113.

a. Tool Equipment.

Tool Equipment TE–113. (Organizations which have fixed plant Tool Equipments TE–87–(*) and TE–88–(*) available can dispense with Tool Equipment TE–113.)

b. Materials.

Orangestick.
Cheesecloth, bleached, lint-free.
Cloth, crocus, 9- by 11-inch sheets (spec No. 42056-Navy).
Carbon tetrachloride.
Paper, sand, flint No. 000 and No. 0000 (Fed spec No. P–P–111).
Solvent, dry-cleaning (SD) (Fed spec No. P–S–661a).

13. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 psi (pounds per square inch) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

14. Use of Preventive Maintenance Forms

a. The information in paragraph 15 is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA AGO Forms 11–238 and 11–239. The decision as to which items on the forms are applicable to this equipment is a tactical decision to be made, in the case of First Echelon Maintenance, by the Communication Officer/Chief or his designated representative, and in the case of Second and Third Echelon Maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. The first two columns of the chart in paragraph 15 serve as a cross-reference between the item numbers of DA AGO Forms 11–238 and 11–239 and the preventive maintenance information in this manual.

15. Performing Preventive Maintenance

The following preventive maintenance operations should be performed at the intervals in-

dicated, unless these intervals are reduced by the local commander.

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

DA AGO Form 11-238 Item No.	DA AGO Form 11-239 Item No.	Daily
1	1	Check for completeness and satisfactory condition of the control unit.
2	2	Check suitability of location and installation for normal operation.
3	3	Clean dirt and moisture from keys, cords, jacks, plugs, and panels of the component parts.
4	4	Inspect the seating of the fuses on the panel (fig. 1) and all plugs and connectors.
5	5	Inspect all controls for binding, scraping, excessive looseness, worn shafts, misalinement, and positive action.
6	6	Check for normal operation (pars. 9 and 10).
		Weekly
		Caution: Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.
7	7	Clean and tighten the panel mountings.
8	8	Inspect case, mounting, and exposed metal surfaces for rust, corrosion, and moisture.
9	9	Inspect cords, cables, wires, and shock mounts for cuts, breaks, fraying, deterioration, kinks, and strain.
11	11	Inspect technical manual TM 11-262 for tears, mildew, or fraying.
	19	Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket spring tension; check emission of receiver type tubes.
	21	Inspect fixed capacitors for leaks, bulges, and discoloration.
	24	Inspect resistors, bushings, and insulators for cracks, chippings, blistering, discoloration, and moisture.
	25	Inspect terminals of large fixed capacitors and resistors for corrosion, dirt, and loose contacts.
	26	Clean and tighten switches, terminal blocks, varistor case, and interior of chassis.
	27	Inspect terminal blocks for loose connections, cracks, and breaks.
	31	Clean and tighten connections and mountings for transformers, potentiometers, and rheostats.
	32	Inspect transformers, potentiometers, and rheostats for overheating and oil leakage.
	37	Check adequacy of moisture proofing and fungiproofing treatment.
	38	If deficiencies noted are not corrected during inspection, indicate what action was taken to correct the deficiencies.

Section II. LUBRICATION AND WEATHERPROOFING

16. Lubrication

The lubrication of the control unit is relatively simple. Clean the shafts and areas adjacent to the switch shaft bearings. Apply one or two drops of special preservative (PL) lubricating oil to the bearings. Wipe off excess oil.

17. Weatherproofing

a. General. Signal Corps equipment, when

operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moisture-proofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

e. Lubrication. The effects of extreme cold and heat on lubricating materials and lubricants are explained in TB SIG 69. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat.

18. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal. Obtain a bright smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. When numerous scars and scratches warrant complete repainting, remove the panels and chassis, and spray paint over the entire case. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations. Refer to TM 9–2851.

CHAPTER 3

THEORY

Section I. SYSTEM THEORY

19. Scope

Control Unit C–292(*)/TRA–7 is used with a combination of *radio* and *wire* equipments working as a unit and involving practices and theory of both. For this reason, a few of the basic principles of teletypewriter theory will be discussed in this section. For detailed data on the theory of teletypewriter components, refer to TM 11–680. The functions of the control unit in a representative RTT system is covered in paragraph 27.

20. Signaling Currents

Radioteletype systems use teletypewriters (telegraph printers) that will operate normally over 10 to 20 miles of unloaded (no extra inductances added) field Wire W–110–B without repeaters or line relays. The distance depends on whether battery (current) is supplied at one or both ends of the line.

a. Methods. Two methods of transmitting TT signals on wire lines are normally used; the *neutral* system and the *polar* system. In the neutral system, use is made of *current on* and *current off* square-wave pulses of one polarity. The polar system uses positive and negative square-wave pulses. Figure 6 shows ideal and practical signal pulses. The transitions from one signal condition to the other, and the timing of the transitions, determines the intelligence conveyed.

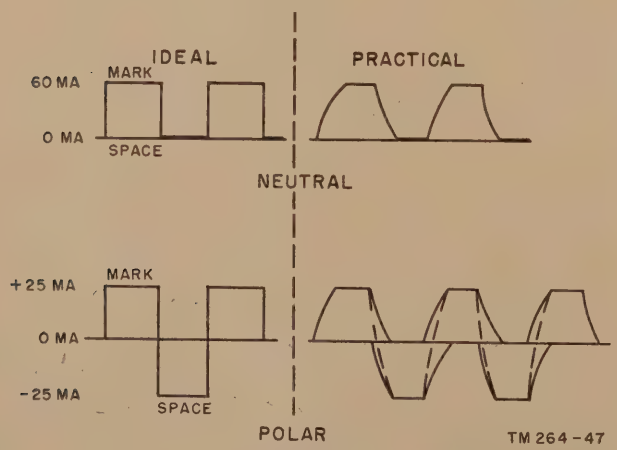


Figure 6. Neutral and polar waveshapes.

b. Neutral System. In the neutral system, current is sent over the line to operate the receiving TT selector mechanisms to a marking position, and the current is stopped to operate the selecting magnets to a spacing position. A marking current of 60 ma normally is used. Neutral operation is used in the loop and extension circuits of this control unit (J103 connections).

c. Polar System. In the polar system, current is sent over the wire in one direction for the marking impulses and in the opposite direction for the spacing impulses. This system possesses a number of advantages over the neutral system and is used in the electronic circuits of the equipments used with this control unit. Two of the major advantages are—

(1) *Apparent voltage gain.* The transmission of current in the opposite direction for spacing gives the effect of increased voltage without increasing the current values in any part of the circuit. Therefore, the circuit is not subjected to as high working voltages as in the neutral system.

(2) *Decreased bias.* The presence of *bias* (lengthening or shortening of the signal wave) on the line has little effect on the resulting waveform of the signal transmitted with polar operation. If the mark and space currents have been correctly adjusted at the sending end of the circuit, the electrostatic charges in the transmission line remaining from the positive and negative impulses cancel, leaving the waveform undisturbed.

d. Use. Neutral operation is used satisfactorily for short lines; it is used also to operate the selector magnets of the TT equipments. Polar operation is invariably used where long lines or highly-capacitive circuits are involved.

21. Teletypewriter Code

a. Assuming that two typewriters are to be connected together by a wire or wires so that messages typed on one would be automatically and simultaneously typed on the other, the first method of accomplishment might be to have each key of the sending typewriter connected by an individual wire to a magnet for a corresponding type bar of the receiving typewriter. Such an arrangement would be very simple in theory, but obviously uneconomical in the amount of material used. An economical method of solving the problem is by sending a sequence of signals, or *code,* for each character, as is done in the case of manual Morse telegraphy. This is the general method used with teletypewriters although the code is considerably altered to adapt it for best machine operation.

b. In selecting a satisfactory code for TT operation, several factors had to be considered, including the following:

(1) The code should preferably use only two line conditions, such as current and no current.

(2) The number of code elements per character should be a minimum in order to permit high-speed operation over relatively narrow-band telegraph circuits. (A greater keying speed is equivalent to more information per unit time; the more information that is transmitted in a given time, the greater the necessary bandwidth.)

(3) The number of code units per character should preferably be uniform in order to give simple machine design.

c. A code answering the general requirements is the one used in our present teletypewriters; it is usually called the 5-unit selecting code. There are 32 possible ways of arranging two current values with respect to five divisions of time, making possible the selection of any one of 32 type bars or other operating mechanisms. By using the upper and lower case for the characters, this code is sufficient to provide for the 26 letters of the alphabet, the 10 numerals, and the usual punctuation marks. It is the shortest practical code for two-line conditions.

d. The mark and space impulses used to operate a teletypewriter are pulses of direct current of uniform intensity (figs. 6 and 7). If oscilloscope test prods were connected across a line carrying these mark and space impulses, they would appear as a square waveform (fig. 6). It is very important that the transmitted impulse maintain its waveform when it reaches

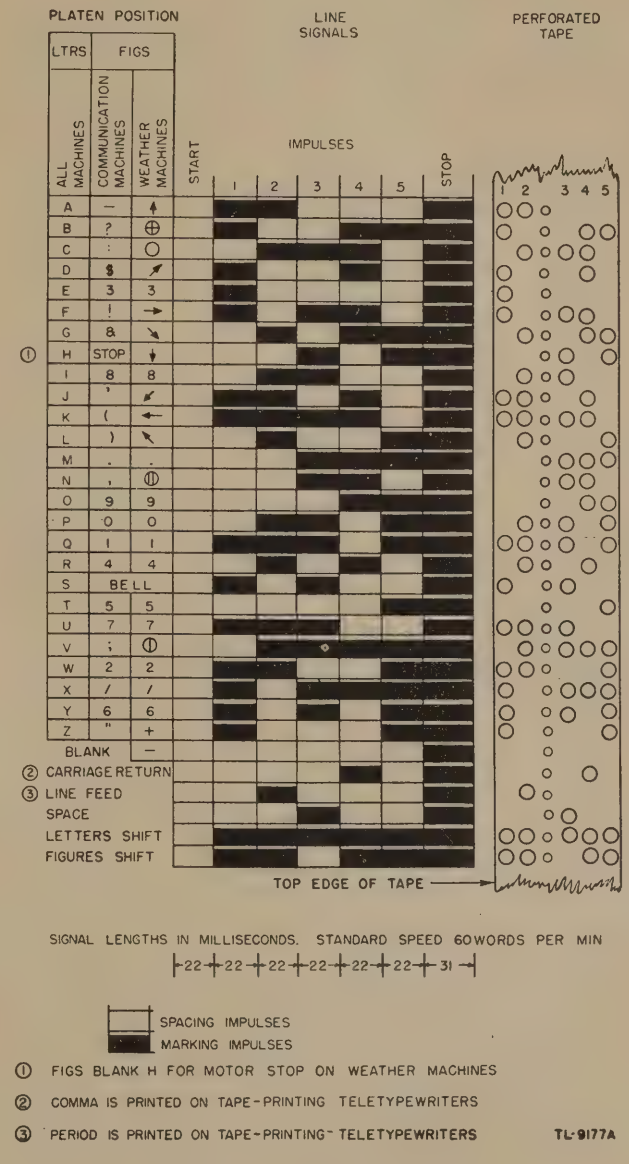


Figure 7. Teletypewriter code.

the receiving apparatus, as a steady impulse is necessary for correct operation of the receiving machine. When sending at 60 wpm (words per minute), assuming a standard five-letter word, the time for each unit signal impulse is 22 ms (milliseconds) (fig. 7). When the

selecting mechanism of the receiving teletypewriter is adjusted correctly, it operates only during the central portion of the received signal impulse, requiring only 20 percent of the unit interval, or approximately 4 ms. It is apparent from the above that there are many factors that may cause false operation of the receiving teletypewriter. Improper adjustment of receiving and sending equipment may result in improper synchronization (par. 22) and consequent false operation. Link (connecting wire) leakage, line resistance, ground resistance, ground potentials (caused by earth currents), and changes in electrical constants in the involved components may all create waveshape distortion.

22. Start-Stop Synchronizing System

a. Having chosen a good selecting code to meet the general requirements, it is necessary next to obtain mechanisms for sending and receiving by means of this code. The depression of a key at the sending instrument must cause automatic transmission of the proper code combination for a particular character, automatic reception of the code, and the printing of the required corresponding character at the receiving instrument. In order to accomplish this there must be some sort of synchronism between the two machines, that is, the operation of one must be definitely related in timing to that of the other. In other words, at the time No. 1 pulse is being transmitted from the sending machine, the receiving machine must be in condition for receiving No. 1 pulse.

b. The start-stop system of synchronizing is the one used with equipments employing this control unit. It requires for its operation that two synchronizing pulses per character be transmitted over the line in addition to the five selecting pulses. The operation of this system may be understood by reference to figure 8. This figure shows a simplified diagram of one form of start-stop system which lends itself readily to explanation. Referring to the figure, the distributor arms are connected to the shaft by means of a friction clutch and normally are held from rotating by latches. The distributor shafts at the sending and receiving ends are adjusted to rotate at approximately the same speed. When a character key is depressed, the first pulse, known as the start pulse, releases the latch at the sending end, and as the distributor arm passes over segment seven (unconnected to the line as it always transmits a *space* signal), it transmits a space to the line.

c. This operates the line relay at the receiving end to spacing, energizing the start magnet and releasing the latch. The receiving distributor arm now starts to rotate. As the shafts

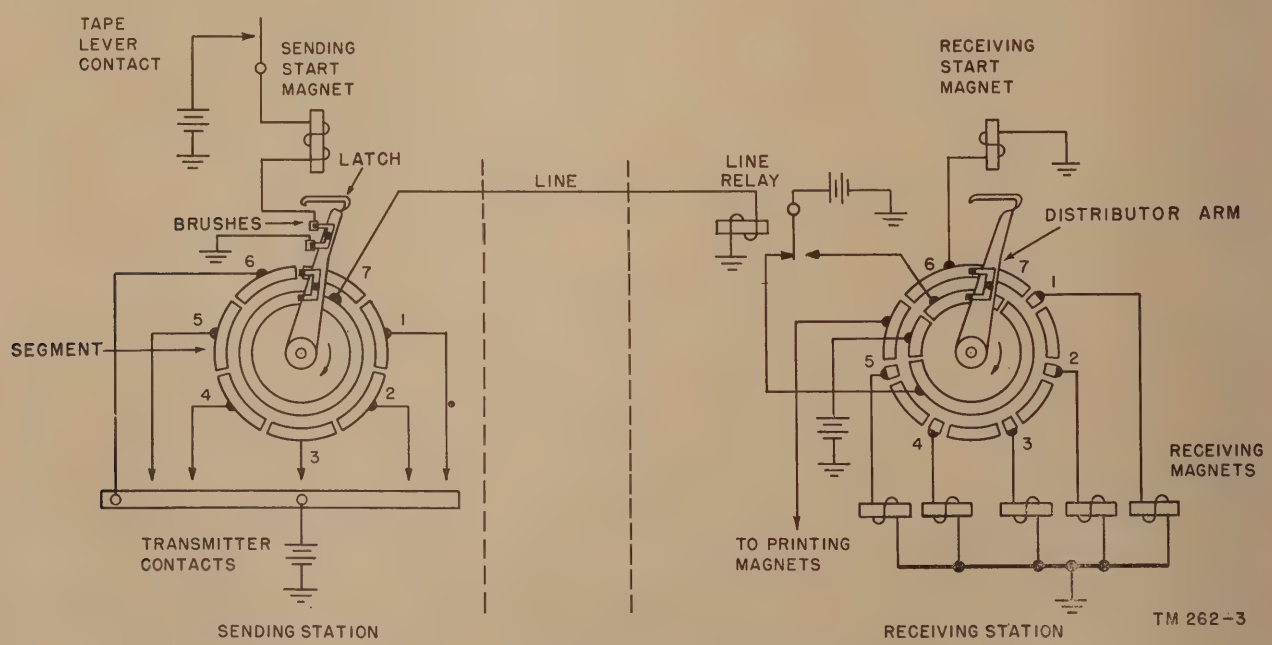


Figure 8. Start-stop synchronizing system.

of the sending and receiving distributors are rotating at approximately the same speed, they will remain practically in synchronism for one revolution. Any selecting pulses sent during this revolution will be received on the proper segments and distributed to the proper receiving magnets (par. 23).

d. When the sending brush passes over the sixth segment, a marking signal is sent and the latch catches the distributor arm and prevents further rotation. This marking pulse holds the receiving line relay to marking, while the receiving distributor arm passes on to the seventh segment and, as the start magnet is not energized, the latch catches the arm and stops it. While the brush arm of the receiving distributor is passing over the sixth segment, the battery which is permanently connected to this segment is connected to a magnet which actuates the printing mechanism and causes the selected character to be printed.

e. As the distributor arm at the receiving end is stopped at the end of each character (on the sixth segment) and started at the beginning of the next one by pulses from the sending end, it is obvious that the lag in the transmission of the pulses over the line will not affect the synchronism between the sending and receiving ends, and several machines can operate at different points on the same line without difficulty.

f. The distributors, which send the signals to the line and receive them from it, are of various types. With regard to the distributor just described, it will be noted that the selecting segments of the receiving distributor are much shorter than of the sending distributor. This is to allow only the middle of each pulse to be used, thus minimizing the effects of distortion. The distributor face can be rotated or oriented with respect to the brush arm (by the *range* adjustment on the TT) so that the most advantageous position can be found for the particular condition.

23. Signal Generation and Reception

a. Figure 9 is a simplified schematic diagram of the sending and receiving circuits of a teletypewriter. The outer segments represent the seven segments of a distributor which also has an inner single-segment ground ring. The seven outer segments may be identified as follows: The reference segment is the long *stop* segment in the 5 to 7 o'clock position and, continuing in a clockwise direction, the next segments in order are *start,* 1, 2, 3, 4, and 5.

b. The condition pictured on the diagram is that for the transmittal of the letter F. At the sending end of the circuit the positions of the sensing-pin contacts indicate that the perforated tape is punched in positions 1, 3, and 4 and not punched in positions 2 and 5 (fig. 7). This is the code for the letter F and is the same code that a depressed F keyboard key would make. As the brush arm makes its revolution, the sending relay will be inoperative during the start, 2, and 5 segments and operative during the 1, 3, 4, and stop segments. The shaded segments receive battery supply via the sending magnet and closed sensing-pin contacts, resulting in *mark* pulses over the line. The unshaded segments do not receive battery supply; this results in *space* pulses over the line. Mark pulses are current pulses; space pulses are noncurrent pulses.

c. The receiving teletypewriter may be described as a device which analyzes the electrical pulses as received from the line and converts them into a mechanical action which prints the character. The receiving selector, which analyzes the train of pulses as received from the line, performs the transition from electrical into mechanical action. Several types of receiving devices may be used. Page and tape-type TT's print the received characters; receiving reperforators may be arranged to print, as well as to punch, the received characters on perforator tape. However, they are all equipped with a receiving selector which may be either a pulling magnet or holding magnet type. Both types perform the same basic function and differ only in the mechanical methods of performing the selection.

d. The code pulses, as received from the line facilities, are presented to the receiving selector magnet one at a time. This magnet, in turn, positions the selector armature to a *mark* or *space* position through the tension of its associated spring. The marking position is illustrated by the solid outline (fig. 9) and the spacing position by the dotted outline of the selector armature. The locking cam is one of seven camming surfaces associated with the receiving cam sleeve. One end of the locking

lever is held against the surface of the locking cam at point designated X under the tension of its associated spring, and the solid outline indicates it is in the released (from the armature) position. The receiving cam sleeve, on which the locking cam is mounted, is driven by the receiving TT main shaft under tension of two friction clutch washers.

e. When the locking cam is permitted to turn and the indents designated 1, 2, 3, 4, and 5 reach position X, the end of the locking lever will fall into the indent and assume the operated position indicated by the dotted outline. When in this position, the other end of the lever engages the sword-like projection on the selector armature and locks it in the position it has assumed at that instant, and which may be in either the marking or spacing position, depending on the pulse being received.

f. When transmitting the letter F, the distributor brush arm is released by the latching control circuit and starts rotating in a clock-

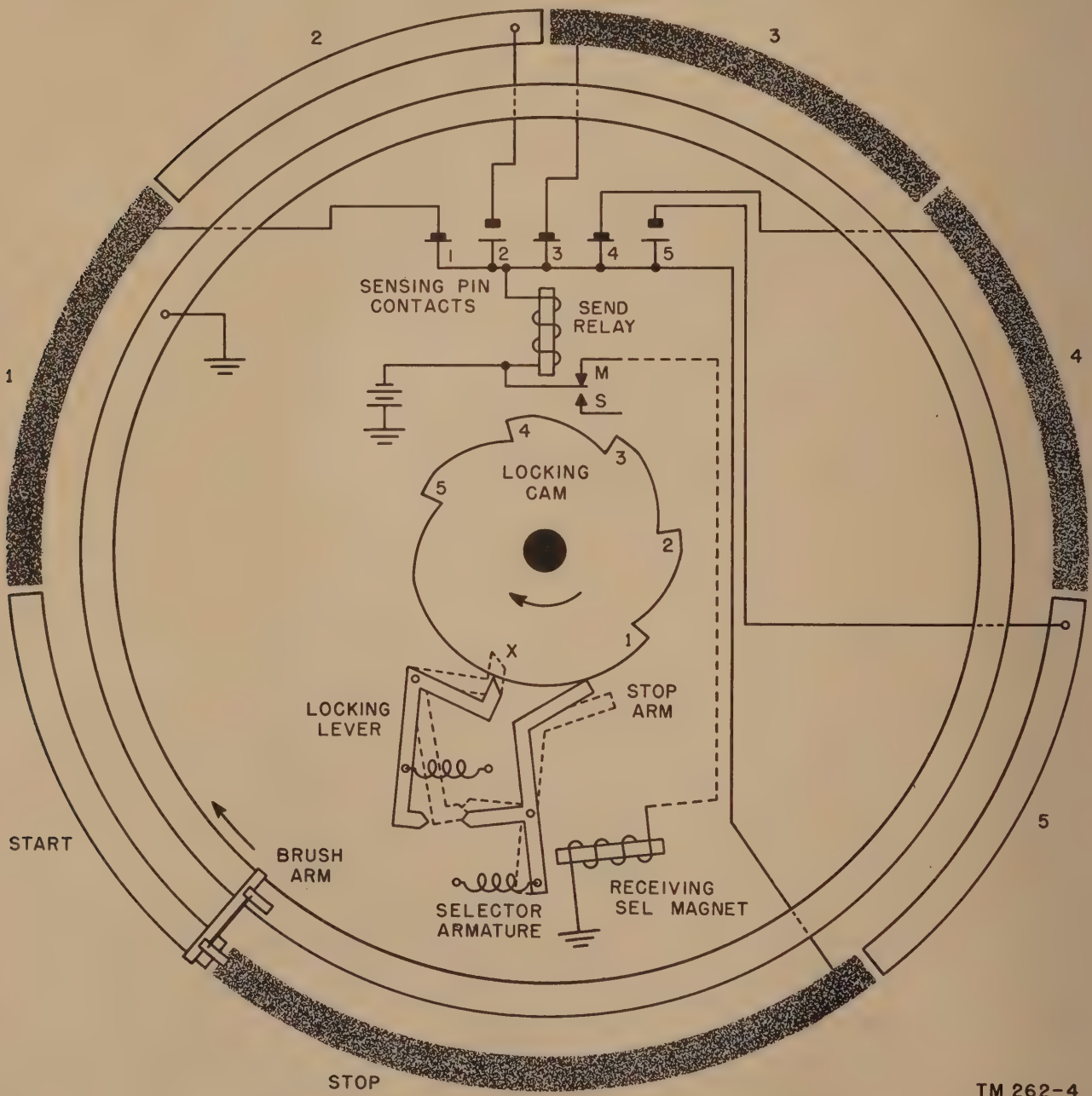


Figure 9. Teletypewriter signal generation and reception.

wise direction. On reaching the start segment, a space pulse will be transmitted and the selector armature will move to the spacing position under the tension of the armature spring. This, in turn, will disengage the armature extension from the stop arm, release the cam sleeve, and permit the locking cam to revolve in a clockwise direction. When the brush arm reaches the first selecting segment and transmits a marking pulse, the selector armature will move into the marking position. When the brush arm travels to the middle of the first selecting segment, the locking cam will have rotated so that indent 1 is at point X, permitting the locking lever to assume its operated position, locking the armature in the marking position.

g. When the sending brush arm arrives at selecting segment 2, it will transmit a spacing pulse, which in turn will deenergize the receiving selector magnet, but the armature, still under control of the locking lever, will not move to the spacing position at this time. However, prior to the arrival of the brush arm at the midpoint of the second selecting segment, the locking cam will ride up on the high part of the cam preceding indent 2 and then permit the armature to change its position. When the brush arm reaches the midpoint, indent 2 will likewise reach point X, causing the locking lever to reoperate and lock the armature in its spacing position. This same function, namely the release and reoperation of the locking lever, is repeated for pulses 3, 4, and 5. The release of the armature for a short period of time is to permit it to change its position as dictated by the pulse generated in the sending distributor and lock it into this position.

h. In this manner, the receiving devices sample the line pulses at fixed intervals of time to determine the type of signal being received at the instant that the locking lever drops into the indents. These are called the *instants of selection* as the receiving device is only concerned with the position the armature has assumed at the instant the locking lever engages the sword-like projection on the selector armature.

i. After the occurrence of the fifth instant of selection, the locking lever rides up on the long high part of the cam and stays in its release position while the stop pulse is being sent. Since the stop pulse is always marking, the selector armature will assume a marking position and (by this time the locking cam having also made a complete revolution) the stop arm will engage the extension at the end of the armature and bring the receiving selected cam to a complete rest. Since the locking lever is now resting on the high part of its cam, this will permit the armature to move to its spacing position upon receipt of the start pulse of the following character. The locking of the armature between instants of selection is to permit other parts of the receiving selector (not illustrated) sufficient time to assume either their marking or spacing position as dictated by the position of the armature for each selecting pulse.

24. Transmitter-distributor

Instead of transmitting from a teletypewriter keyboard, it is frequently of advantage to transmit automatically by means of perforated tape. (Portions of this tape are shown in the right side of figure 7 and in figure 10.) With this type of transmission, one or more operators may perforate tape as fast as it is convenient, and the previously prepared tape may be hand-fed through the automatic transmitter at a uniform rate, making use of the maximum speed capabilities of the circuits. The machine used for automatically transmitting from perforated tape is called a *transmitter-distributor,* normally abbreviated TD. In the TD, a tape transmitter using the perforated tape sets up the code combinations to be transmitted on a set of five contacts. A commutator distributor (which corresponds to a distributor in an automobile) connects the line of each of these contacts in proper sequence at a speed of 60 wpm. The signals are transferred to the line through a distributor brush revolving around a commutator face which is split into seven segments. The brush first passes over the start segment, sending a space impulse over the line. As it continues to revolve, it successively connects the five code segments to the line for a character. Then the brush reaches the stop segment and sends out the stop impulse, a mark. Thus, one character is sent per revolution of the commutator brush. The output signals of a

TD are neutral; that is, current flows during a mark impulse and no current flows during a space impulse. With the TD connected to a line circuit and in its idle (not transmitting) condition, its distributor brush will remain on the stop segment, sending a steady mark. For a detailed discussion of the TD, refer to TM 11–2222.

25. Typing Reperforator

a. The typing reperforator is a motor-driven mechanism for receiving and recording the messages in both code perforations and typewritten characters on the same tape. When used with a keyboard in local circuits, it serves the purpose of a keyboard tape perforator and TT transmitter. Receiving units of this kind are particularly adaptable for use at message centers, because the perforated tape may be prepared and later used to retransmit the message to one or more stations by means of a TD. This eliminates the necessity for manual transmission by direct keyboard or manual preparation of perforated tape. The typewritten characters on the tape facilitate identification and distribution at the message center.

b. The typing reperforator uses a standard perforator tape which is eleven-sixteenths inch wide. A method of tape perforating known as *chadless perforating* is used to permit perforation of the tape in the same space that is occupied by the typewritten characters. The punchings, or chads, are not completely severed from the tape but remain attached to it at their leading edges to form lids over the holes (fig. 10). The legibility of the typewritten character is not impaired by this type of perforating because the perforating does not eliminate any portion of the tape.

c. Typing and perforating occur simultaneously, but since the typing platen is to the right of the perforator die block, characters are typed at the right of their respective perforation. *The separation between the typewritten character and its associated perforation is six character spaces.* This separation must be taken into account when tearing message tapes from the unit or in cutting the tape. When the tape is to be used for transmission by means of the TD, the end of the tape should include all the typewritten characters in the message, and the first typewritten messages must be preceded by at least six sets of code perforations in order to transmit the entire message. Detailed information covering the typing reperforator can be found in TM 11–2223.

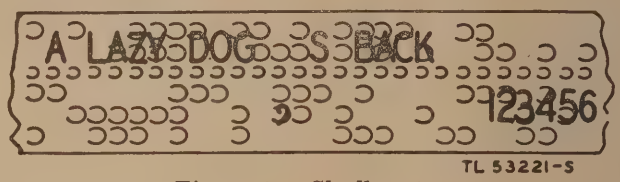


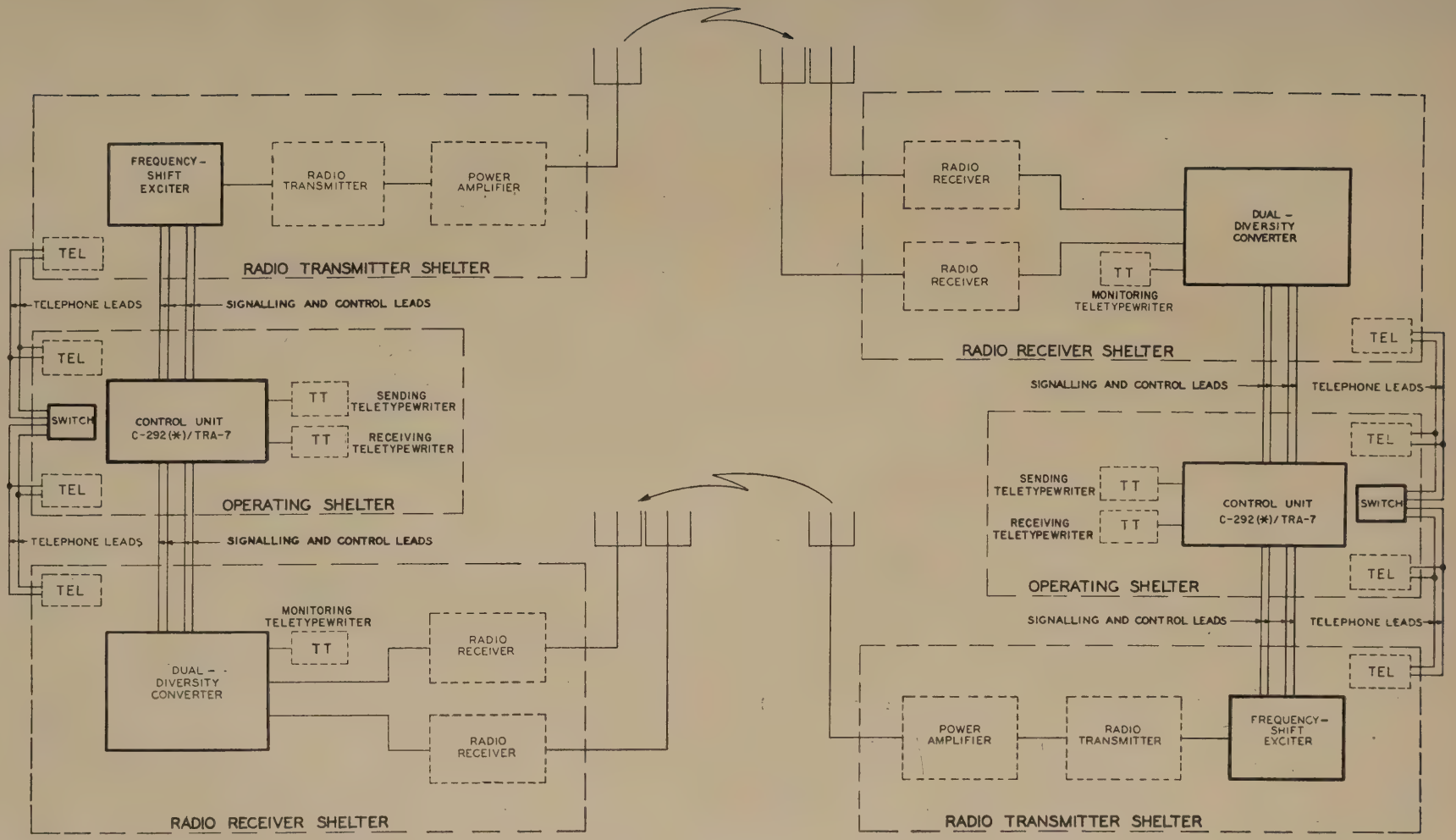
Figure 10. Chadless tape.

26. Perforator

The TD can handle both the chad and chadless types of tape. Chad tape (right side of fig. 7) is produced by a perforator with a standard teletypewriter keyboard. When a key is depressed, the desired code combination is recorded on the tape by perforating for the mark impulses and by not perforating for the space impulses. The start and stop impulses are not recorded on either type of tape. The small continuous line of holes in the tape (both chad and chadless types) are used to feed the tape through the perforator and the TD. The tape is read by moving it from right to left with two recorded impulses above the feed line and three below the feed line. The perforating mechanism consists essentially of a set of punches for perforating tape, a pair of punch magnets, and a punch hammer for operating the punches. Depressing a key positions six selector bars, five of which, through a series of lever actions, select the punches that are to be operated. The sixth selector bar closes the electrical circuit through the punch magnet, resulting in the punches being operated by the punch hammer. This type of perforator punches the tape clean.

27. System Functioning

a. Figure 11 is a block diagram of equipment at two radioteletype terminals set up to permit full-duplex operation. Each terminal consists of a receiving section, an operating section, and a transmitting section. The three sections may be in separate shelters or all in one shelter. The diagram shows a sending and receiving teletypewriter at each operating shelter, and monitor TT's in the receiving



NOTE:

IN SOME RADIO SETS, ALL COMPONENTS OF ONE STATION MAY BE MOUNTED IN ONE SHELTER.

TM 262-5

Figure 11. Block diagram of two radioteletype ter minals arranged for full-duplex operation.

shelters. This RTT system uses frequency-shifted r-f (radio-frequency) signals of constant amplitude. C-w telegraph signals may be originated using a hand telegraph key or a code tape transmitter. The receiving station may be equipped to receive keyed tones or neutral signals which may be copied manually or recorded automatically on a typing reperforator.

b. Opening and closing of the sending contacts at the TT operating station produces signals which are transformed electronically in the control unit into polar signals. The polar signals are transmitted over field wire to control the operation of a tube in the frequency-shift exciter which, in turn, controls the mark and space frequencies of the transmitted signals. During mark intervals, the usual radio transmitter operates on a normal frequency between 2 and 18 mc (megacycles). During space intervals, the transmitter frequency is reduced by 850 cycles. (L-f transmitters (below 2 kc (kilocycles)) use a shift of 170 cycles.)

c. At the receiving station, duplicate incoming r-f signals are received on two different antennas spaced several wavelengths apart. Each antenna is connected to a separate superheterodyne receiver located in the receiving shelter. The use of two antennas and two associated radio receivers minimizes the effects of fading which tends to weaken the signal at one receiving location, but not at another. The transmission paths to each antenna normally are not affected at the same time or to the same extent and, consequently, the combined output from both receivers produces a signal of relatively constant strength. The i-f (intermediate-frequency) outputs of both receivers are applied to the dual-diversity converter. In this unit, the i-f signals are converted to lower frequencies which, in turn, are demodulated by two frequency-discriminating networks. The demodulated output of the FS converter consists of both neutral and polar teletype signals. The neutral signal operates a monitor TT located at the receiving position. The polar signal is sent over land lines to the control unit where it is converted into a neutral signal which operates receiving teletypewriters at the operating shelter.

Section II. THEORY OF CONTROL UNIT

28. Block Diagram
(fig. 4)

The basic functional circuits of Control Unit C–292(*)/TRA–7 are shown in the block diagram (fig. 4) and consist of a receiving circuit, a sending circuit, and a power supply. Complete schematics of the control unit appear in figures 33 and 34. The external circuits and equipment associated with the operation of the control unit are also indicated in figure 12. The blocks drawn with solid lines generally are located in the operating section (shelter) with the exception of additional TT's which may be located some distance from that point.

a. Receiving Circuit. The receiving circuit converts TT (or telegraph) polar signals from the dual-diversity converter into neutral d-c signals. These neutral signals energize, through external receive extension circuits, the printing selector magnet in the teletypewriter. In some cases the neutral signals are applied to a receiving relay or a Line Unit BE–77–(*) which, in turn, controls current to operate the TT selector magnet.

b. Sending Circuit. The TT sending contacts are connected, through the send extension circuit, to the input of the control unit sending circuit. The neutral signals, formed by the open (space) and closed (mark) teletypewriter sending contacts, are converted into polar signals by the sending circuit. These polar signals key the frequency-shift exciter.

c. Power Supply. The power supply provides both a-c and d-c voltages required to energize and to operate the circuits of the control unit and associated receiving teletypewriters and also supplies polar current for the FS exciter line.

29. Receiving Circuit Signal Path
(fig. 13)

a. The receiving circuit of the control unit uses two sharp cut-off pentode amplifiers, V101 and V103 (6SJ7 type tubes), and a beam-

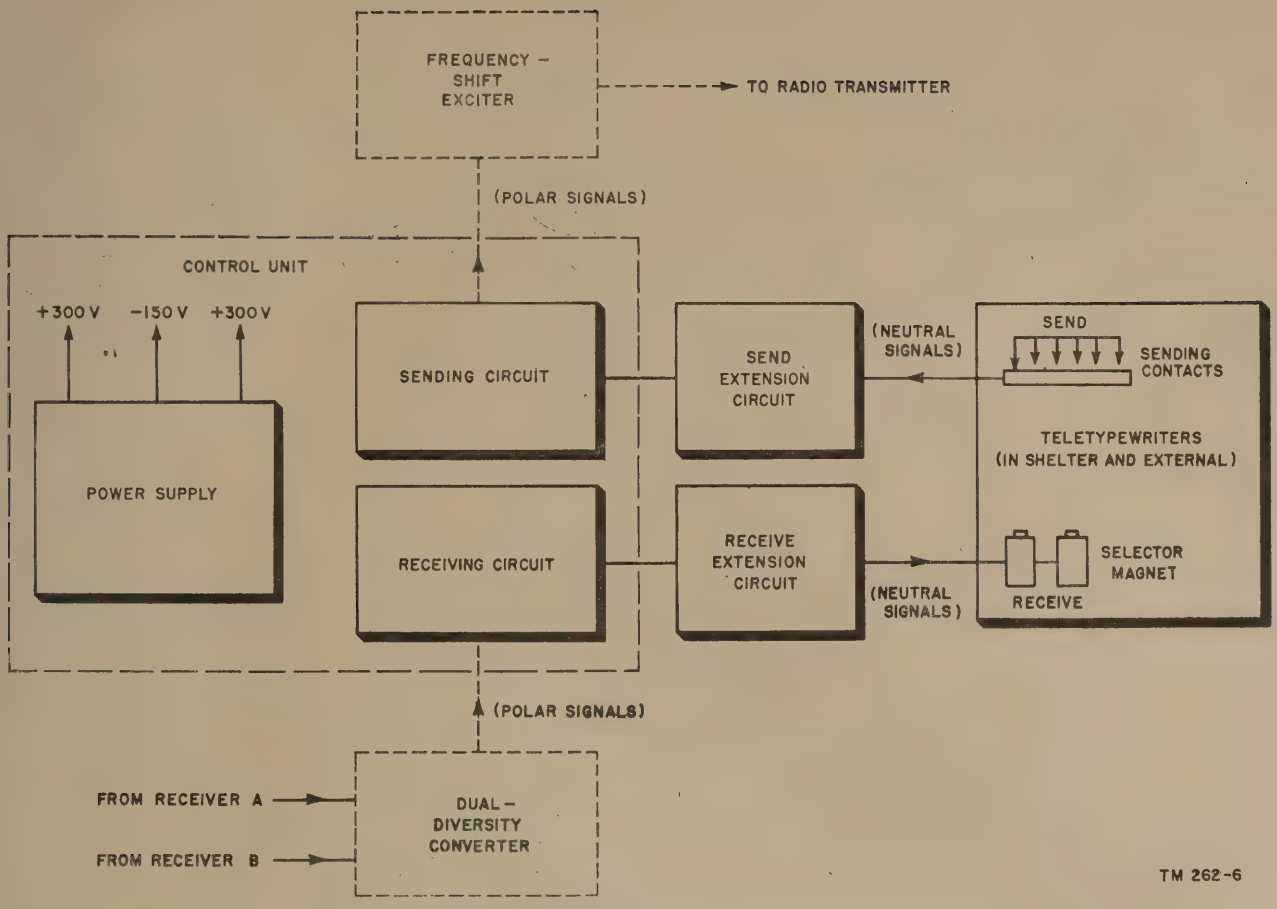


Figure 12. Block diagram of Control Unit C–292(*)/TRA–7.

power amplifier, V104 (a 6Y6G tube), to convert the polar signals from the dual-diversity converter into neutral signals which are applied to the receiving teletypewriter selector magnet. Twin-diode rectifier V102 (a 6H6 tube) is used to improve operation of the receiving circuit by limiting input voltage peaks.

b. The three amplifier tubes of the receiving circuit (V101, V103, and V104 of fig. 13) do not function as conventional amplifiers but act like switches which are either on (conducting) or off (nonconducting). A tube that is off applies a positive potential to the grid of the following tube, turning it on. This second tube then applies a negative voltage considerably greater than cut-off to the grid of the next tube, turning it off. These positive and negative potentials are indicated by plus (+) and minus (—) signs at the inputs and outputs of the symbols indicating tubes in the functional block diagram of the receiving circuit (fig. 13). The amplifier tubes are drawn as switches and inclosed in circles on the block diagram. A tube that is *off* is indicated by an open switch within a circle which has no shading. A tube that is *on* is shown as a closed switch within a shaded circle.

c. The sequence of tube operation produced by a mark signal is shown in A, figure 13. When a mark signal is applied to the primary of input transformer T101, a rising negative voltage appears across the secondary. As the secondary voltage increases beyond —15 volts, the mark-clipping half of V102 conducts and limits the secondary voltage to approximately that value. The secondary voltage applied to the grid of mark-space switching tube V101 is negative with respect to the V101 cathode, and is greater than the grid cut-off value of V101. Tube V101 is turned *off*, its plate voltage rises, and a positive voltage is applied to the grids of receive extension driving tube V104 and mark-space locking tube V103. Tube V103 conducts and the voltage at its plate becomes negative with respect to the grid of V101. The grid circuit of V101 is connected to the plate

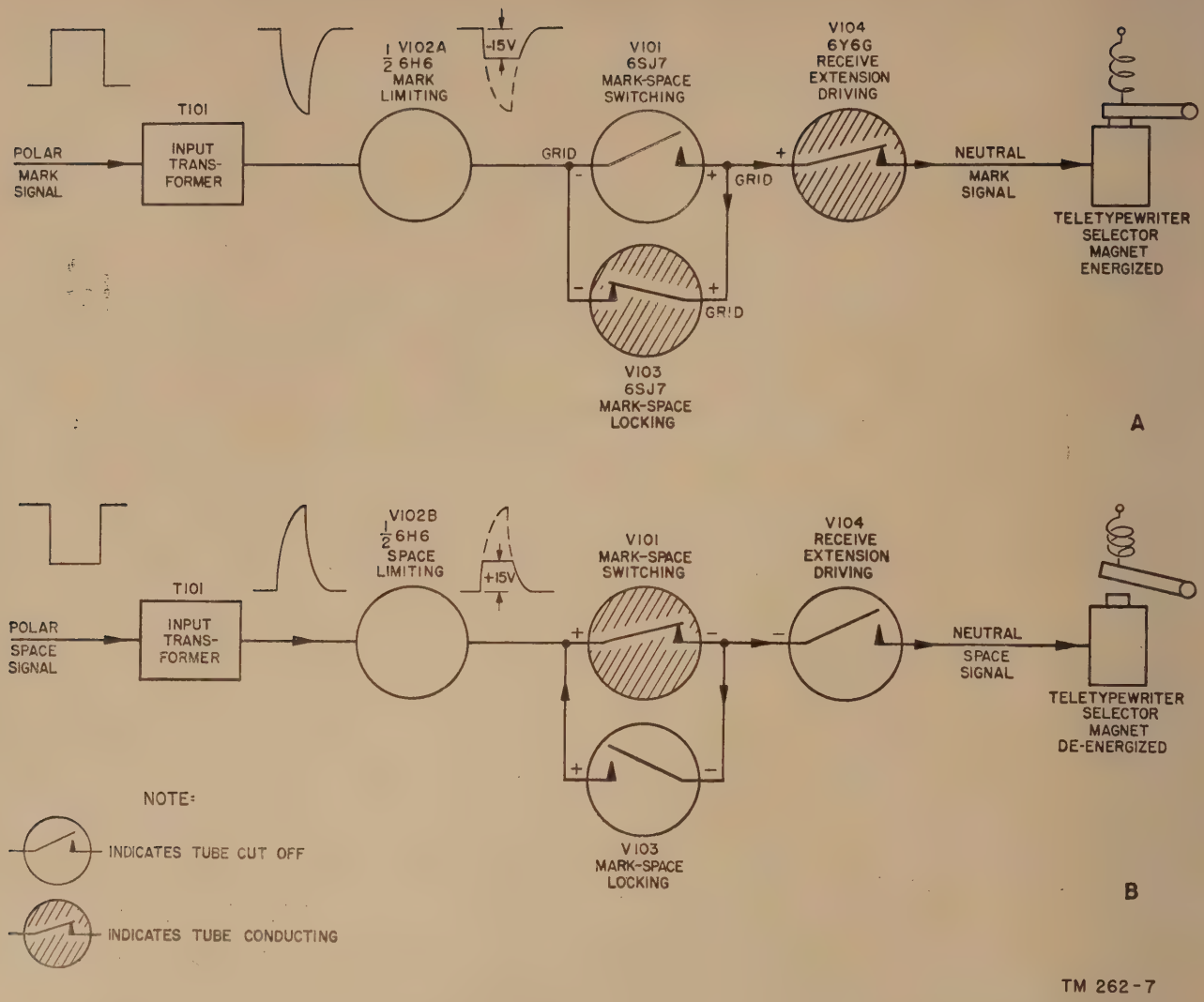


Figure 13. Control unit receiving circuit, sequence of tube operation for mark and space signals.

of V103, and V103 holds V101 in an *off* or mark condition. When V101 is *off* the positive voltage applied to the grid of receive extension driving tube V104 turns that tube *on*. The plate current of V104 flows through the TT selector magnet coil, energizing the selector magnet for the mark signal. The receiving circuit remains in the mark condition until a space signal is received.

d. When a space signal arrives at the primary of T101, the primary current flow reverses, inducing a positive secondary voltage. The rising secondary voltage initiates the sequence of receiving circuit tube operation shown in B, figure 13. As the secondary voltage rises above +15 volts, the space-limiting half of V102 conducts and limits the voltage to approximately that value. The space signal voltage at the grid of mark-space switching tube V101 is positive with respect to that at the cathode, and V101 conducts. The V101 plate voltage drops and a negative voltage, greater than cut-off value, is applied to receive extension driving tube V104 and mark-space locking tube V103. Plate current flow of the receive extension driving tube stops, and the teletypewriter selector magnet is deenergized for the space signal. At the same time, mark-space locking tube V103 is cut off, and its plate voltage rises, impressing a positive voltage on the grid of V101, and holding the circuits in a space condition until the reception of a mark signal.

30. Receiving Circuit Operation

a. Operation of the control unit receiving circuit may be analyzed by examination of the schematic diagram of figure 14, which shows both the control unit receiving circuit and an external extension receiving circuit. Polar signals from the dual-diversity converter are applied to pins A and B of control unit input jack J101. Pins A and B are connected to the primary of input transformer T101, in series with meter-current resistor R101 (36 ohms). When a mark signal is transmitted by the dual-diversity converter, current enters at pin B of J101, flows through R101, through the primary of T101 (terminal 2 to 1), and out through pin A of J101. The voltage developed across R101 by mark or space signal current is applied to the meter circuit of M101 and R156 (when METER switch S105 is in the RECLINE CURRENT position), producing a deflection of the meter needle to the right (+) on marking signals and to the left (—) on spacing signals. (The complete metering circuit is shown in figs. 33 and 34.) The amplitude of the incoming mark and space currents read on M101, are adjustable at the receiving shelter by means of a control on the dual-diversity converter. The nominal line current for either signal is 25 ma, but the value of M101 multiplier resistor R156 is such as to cause the meter to read about three times that value.

b. The mark and space signals sent out by the dual-diversity converter are essentially square-wave voltages. Because of receiving line capacitance and inherent input-transformer characteristics, the voltage appearing across the transformer (T101) secondary is of distorted form. When a marking signal is received, the voltage induced in the T101 secondary is applied across load resistor R104. This voltage is negative at terminal 4 with respect to terminal 3. Terminal 4 is connected to the grid of mark-space switching tube V101 through resistors R103 and R102. Resistors R103 and R102 isolate the T101 secondary from the V101 grid, limit grid current, and reduce the loading effect of V101 grid current on the T101 secondary. R102 is to provide limiting when the RECEIVING TEST SPACE button is depressed. (This applies +15 volts to the control grid to simulate on incoming space signal.) The positive side of the mark-signal secondary voltage is applied to the V101 cathode through d-c blocking capacitor C101 (.02 uf (microfarad)). Capacitor C101 isolates the high-impedance grid circuit of V101 from the relatively low-resistance cathode circuit, thus allowing application of grid-control voltages from other high-resistance voltage-switching circuits. Resistors R108, R109, R110, and R111 form a voltage-dividing network across the —150-volt supply.

c. Mark-space limiting tube V102 has two diode sections. The pin 5 plate is associated with the pin 8 cathode and is the mark-limiting section. The pin 3 plate is associated with the pin 4 cathode and is the space-limiting section. The mark-limiting section provides an a-c circuit across the secondary of T101 (from terminal 4 to terminal 3) through resistor R117 and capacitor C101. Normally, the tube is cut off because of the d-c potentials applied to it during reception of a mark signal. The pin 5 plate is connected to a —165-volt potential at the junction of R121 and R117 on the voltage divider composed of R121, R117, R118, R119, and R120. This voltage divider is connected between the outputs of the —300-volt and +300-volt supplies. The —150-volt supply is connected to the —150-volt point on the divider. The pin 8 cathode of V102 is connected to terminal 4 of the T101 secondary and returned to the —150-volt supply through the secondary of T101 and resistors R105 and R107. Thus the plate is 15 volts negative with respect to the cathode and this tube section is normally nonconductive. When a mark-signal voltage appears across the secondary, the upper end of the secondary (terminal 4) and the pin 8 cathode of V102 become negative with respect to the lower end (terminal 3) of the T101 secondary. As the mark-signal voltage increases, the potential at the pin 8 cathode increases in the negative direction. When the rising negative voltage on the pin 8 cathode reaches about 15 volts, the pin 5 plate becomes positive with respect to the pin 8 cathode, and that section of the tube starts to conduct. As the T101 secondary mark voltage increases, current flow through the mark-limiting section (pin 8 to pin 5) of V102 increases, placing a high-resistance short

across the transformer secondary and tending to limit the secondary mark voltage to about —15 volts between the V101 grid and cathode circuits. The action of the space-limiting half of V102 (pin 3 plate and pin 4 cathode) may be traced through in the same manner. In this case, the pin 4 cathode is biased +15 volts positive with respect to the pin 3 plate and this section of V102 does not conduct until the T101 secondary space signal voltage rises to about +15 volts.

d. When a mark signal is applied to the T101 primary, the secondary voltage rises rapidly to the limiting value of —15 volts which is approximately twice the cut-off value of V101 (and V103). Thus, V101 is cut off and plate current flow through resistors R113 and R114 stops. Tube V101 plate voltage at point *A* (fig. 14) rises sharply in a positive direction towards the limiting value of +45 volts, established by bleeder current flow through the network of R113 and R114 in series with the network of R115 and R116 in parallel with R128 and R129. The potential across the entire network is 600 volts, and the current flow through R113 and R114 is approximately 2.61 ma, dividing into .09 ma through R115 and R116 and 2.52 ma through R128 and R129. The resistance networks of both R115 and R116, and R128 and R129 are voltage dividers, the upper ends of which are connected to point *A*, the lower ends to —300 volts. As the voltage at point *A* rises when V101 is cut off, the voltage drops across both voltage dividers (R115, R116 and R128, R129) increase. The lower ends of the networks are at a fixed —300-volt potential, but the voltage at the upper ends and also at intermediate points *B* and *C*, connected to the grids of V103 and V104, rises in a positive direction. This voltage increase is sufficient to drive the grids of both V103 and V104 positive with respect to the cathodes (which are at a —150-volt potential), thus causing the tubes to conduct.

e. When receive extension driving tube V104 conducts, plate current flows through V104, through section B of OPERATION switch S104 (NORMAL position), through current-limiting resistor R130, through one section of SERVICE switch S102 (FULL DX position), through M101 meter current shunt R152, to pin D of J103 on the rear of the control unit, then through the receive extension lines to the coil of the teletypewriter receiving selector magnet. Tube V104 current then flows through the selector magnet coil, back through the external (to the control unit) lines to pin E of J103, to current-limiting resistor R131, and to ground, which is 150 volts positive with respect to the cathode voltage of V104. Meter M101 indicates this current when METER switch S105 is in the REC EXTENSION CURRENT position.

f. When mark-space locking tube V103 conducts (as V101 is cut off on a mark signal), V103 plate current flows through plate load resistors R123 and R124, increases the voltage drop across them, and lowers the voltage at points *D* and *E*. Resistors R125, R126 (BALANCE ADJ control) and R127 form a voltage divider between the plate of V103 and the —300-volt supply. The proportions of the resistors of this voltage divider (R125, R126, R127) and of the added network of R106 and R107 connected to the —150-volt supply are such that the voltage at point *E* drops to about —20 volts with respect to the —150-volt supply. The —20 volts is applied to the grid of V101, through isolating resistor R105 and through the T101 secondary, holding V101 to cut off even though the negative mark voltage pulse (which first cut off V101) has decreased to conduction value. When V101 is held off, receive extension driving tube V104 is held on. V104 plate current through the teletypewriter selector magnet coil keeps the magnet energized and in a mark condition. The value of V104 plate current flowing through the coil (and external circuit) is adjusted by rotation of EXTENSION CURRENT control R110 that varies the screen voltage of V104.

g. As long as a mark signal is applied to the input of T101, the receiving circuits are maintained in a mark condition. At the instant a space signal is applied to T101 primary, there is a sharp reversal of input voltage and current flow through the primary winding. The reversed space signal current induces a T101 secondary voltage, the polarity of which is positive at the V101 grid. When V101 conducts, resistor R108 provides cathode bias which, together with the negative grid bias developed across resistors R102 and R103, sharply limits plate current and produces a square wave

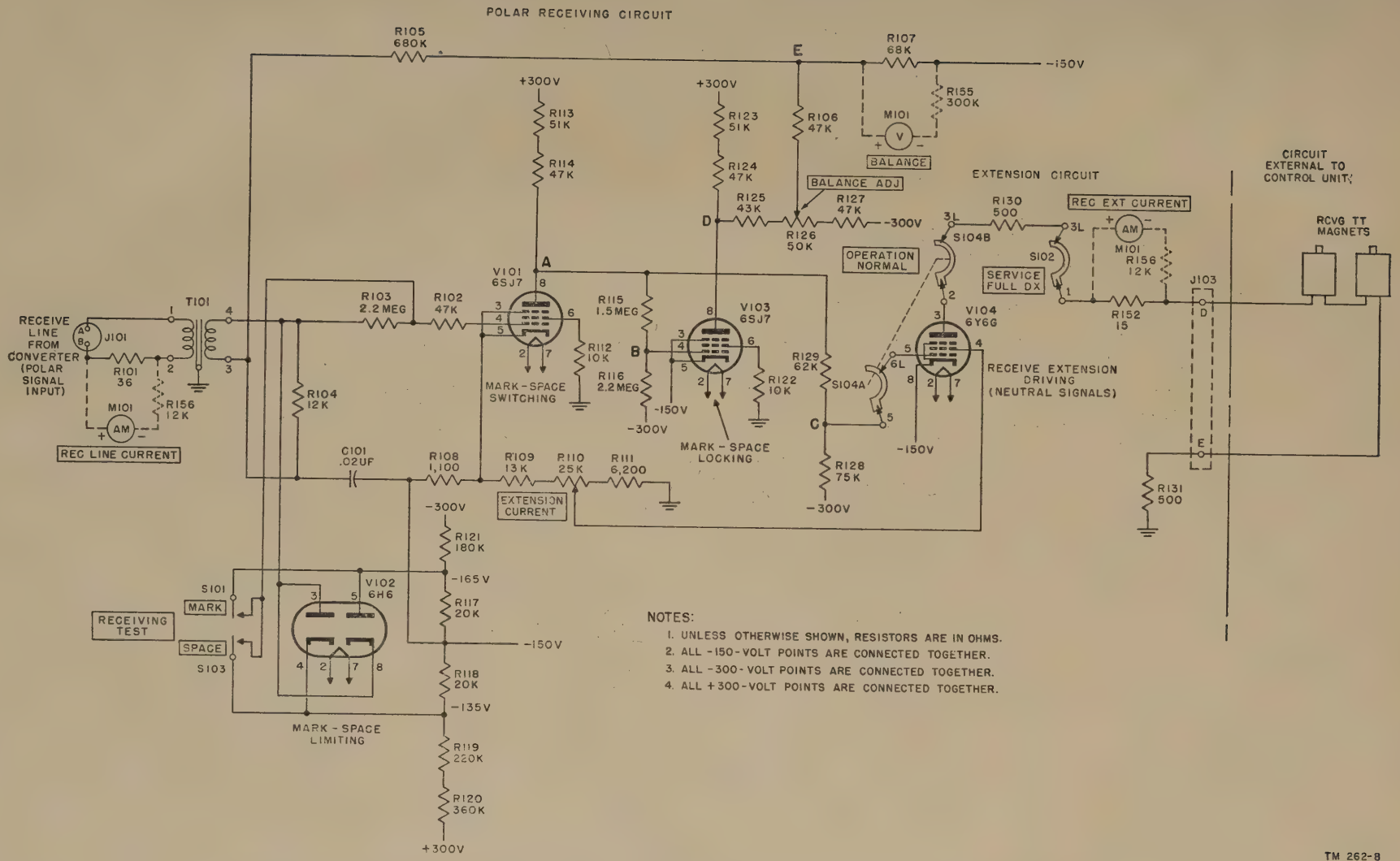


Figure 14. Simplified schematic diagram of receiving circuit arranged for full-duplex operation.

of output voltage at the V101 plate despite variations in the positive applied grid voltage. The action of the space signal may be traced through the circuits of V101, V102, V103, and V104 in similar fashion to that produced by the mark signal. Tube V101 conducts, V102 now clips and limits the positive voltage at the grid, and V103 is cut off, locking V101 in the space (conducting) condition. V104 is also cut off and plate current flow through the TT selector magnet stops, thus releasing the selector magnet armature to the space position.

31. Sending Circuit Signal Path (fig. 15)

a. The sending circuit of the control unit uses sharp cut-off pentode amplifier V107 (type 6SJ7 tube) and two beam-power amplifiers, V105 and V106 (type 6V6GT tubes). Neutral send keying tube V107 is operated by the neutral signals from the teletypewriter sending contacts. Tube V107 controls polar-space driving tube V106 and polar-mark driving tube V105, producing polar signals which are sent to the FS exciter (fig. 16).

b. The tubes of the sending circuit (V105, V106, and V107) operate in the same *on-off* fashion as those of the receiving circuit. Figure 15 shows the sequence of sending-circuit tube operation for an input-space signal and for an input-mark signal. When a neutral-space signal is transmitted by the teletypewriter sending contacts (contact open), a high negative voltage appears at the grid of V107, cutting that tube off. When V107 is nonconducting, a positive voltage is applied (from the plate network of V107) to the grid of polar-space driving tube V106, which conducts and produces spacing signal current in the send line to the exciter. At the same time, V106 plate current cuts polar-mark driving tube V105 off, making it inoperative.

c. A neutral-mark signal is transmitted by closing a sending contact of the teletypewriter.

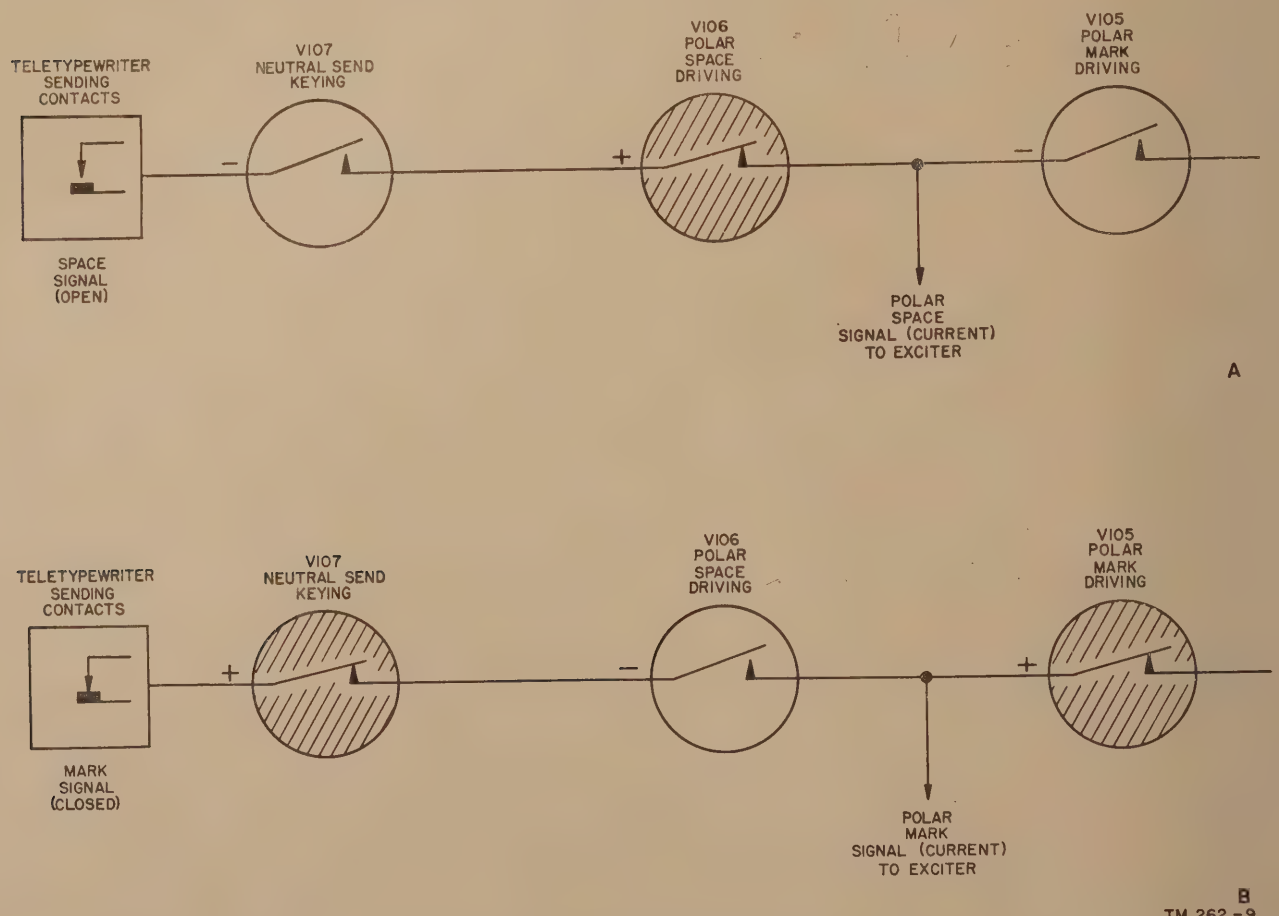


Figure 15. Sending circuit, sequence of tube operation.

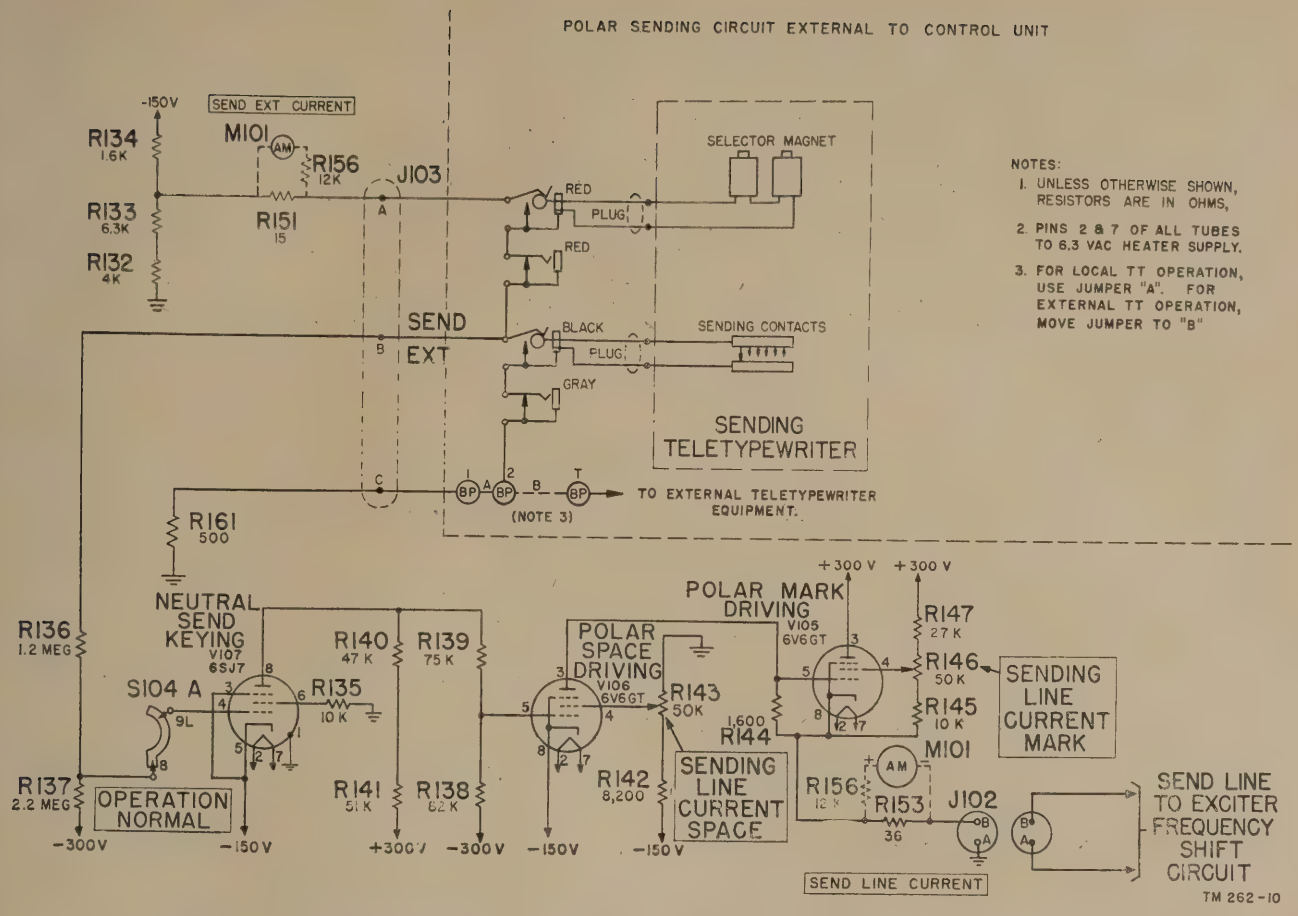


Figure 16. Simplified schematic diagram of sending circuit and send extension connections.

The closed contact produces a positive voltage at the grid of neutral send keying tube V107, turning that tube *on*. Tube V107, when conducting, applies a high negative voltage to the grid of polar-space driving tube V106, cutting V106 off and making the tube inoperative. Tube V106, when cut off, applies a positive voltage to the grid of polar-mark driving tube V105, causing V105 to conduct and to draw mark current through the line to the frequency-shift exciter.

32. Sending Circuit Operation

a. The complete sending circuit operation may be traced through on the simplified schematic diagram of figure 16. During operation, plugs from the sending teletypewriter in the operating shelter are inserted in jacks of the send extension (SEND EXT) circuit, and the teletypewriter selector magnet is energized in series with the sending contacts (through pin A of J103). The opening and closing of the sending contacts operate the selector magnet, as well as the polar sending circuit. Whatever copy the operator sends is thus printed by the sending teletypewriter for monitoring and checking.

b. When the red sending teletypewriter plug (connected to the selector magnet) and the black plug (connected to the sending contacts) are inserted in their corresponding jacks in the SEND EXT junction box, the selector magnet is connected to a current source in the control unit and to the sending contacts. The current source is a voltage divider composed of R132, R133, and R134, connected between the —150-volt supply and ground. When the TT sending contacts are closed for a mark signal, current flows from the junction of R133 and R134, through M101 meter-current multiplier R151, through pin A of control unit jack J103 and to the selector magnet through the tip connector of either of the red jacks in the junction box. From the other side of the selector, magnet current flows back through the sleeve connections of the red plug and jack

to the sending contacts (through the tip connections of the black jack and plug) and then through the sleeve connection to binding posts 2 and 1, pin C of J103, and through R161 to ground. Meter M101 indicates the current in the external line when METER switch S105 is in the SEND EXT CURRENT position. When external teletypewriters are used, binding posts 2 and T are connected by jumper B (A is removed), and the current flows to ground at the remote location; R161 being replaced by the resistance of the line and remote TT.

c. At the same time that the sending contacts are completing a circuit for the printer selecting magnets, they energize the polar sending circuit by grounding the upper end of the voltage divider (R136 and R137) in the grid circuit of neutral send keying tube V107. Grounding the upper end of R136 applies to V107 a grid voltage, which is positive with respect to the —150-volt cathode supply, thus causing V107 to conduct. Plate current flows through resistors R140 and R141, and the V107 plate voltage decreases. The plate voltage drop is passed on to the V106 grid voltage divider composed of R138 and R139, and the grid voltage of V106 becomes sufficiently negative to cut off that tube. When V106 plate current ceases, the V105 biasing voltage across R144 vanishes, and polar mark driving tube V105 conducts. Cathode current of V105 flows from the control unit chassis ground through the line to the FS exciter, returns to the control unit through B of J102, through R153 (36 ohms), and through V105, thus sending a mark signal current through the exciter line.

d. During a space signal, the sending contacts of the transmitting teletypewriter are open. The upper end of the V107 neutral send keying tube grid voltage divider (R136, R137) is then connected through the selector magnet to a high negative voltage from the current-supply voltage divider (R132, R133, and R134). The voltage at the grid of V107 is then approximately 50 volts negatively greater than cut-off, and V107 stops conducting.

e. As V107 is cut off, the V107 plate voltage rises in a positive direction, increasing the voltage across V106 grid voltage divider, which is composed of R139 and R138. The voltage at the junction of R138 and R139 (V106 grid) also increases until it is positive with respect to the —150 volts at the cathode, and V106 conducts. When V106 conducts, space signal current flows up through the V106 cathode, and through resistor R144, in such a direction as to produce a voltage drop which cuts off V105. Space signal current also flows through M101 meter current resistor R153, through pin B of J102 on the rear of control unit, to the FS exciter circuit, back through pin A of J102 to control unit chassis ground.

f. Polar signal current thus flows through the line in one direction for mark signals, and in the opposite direction for space signals. The mark-signal current is +20 ma (M101 meter indication +60) and is adjusted by rotating the shaft of SENDING LINE CURRENT MARK control R146. The space-signal current is —25 ma (M101 meter indication —75) and is adjusted by rotating the shaft of SENDING LINE CURRENT SPACE control R143. These two controls adjust the screen voltages of their respective stages, thus changing the plate current accordingly.

33. Extension Circuits
(figs. 17 through 19)

a. Figure 17 is a simplified schematic of the control unit extension circuit arranged for full-duplex RTT operation. The operating condition of full-duplex, half-duplex, or one-way reversible is controlled by rotation of SERVICE switch S102. The operation of neutral receive extension driving tube V104 (fig. 14) has been described in paragraph 30 and the functioning of the neutral send keying tube V107 (fig. 16) has been described in paragraphs 30 and 31. If the teletypewriters are located in the operating shelter, binding posts 3 and 4 are strapped to complete the receiving TT circuit to ground (through R131), and binding posts 1 and 2 are strapped to complete the sending TT circuit to ground (through R161). If external TT equipment is used, the straps shown at A are removed and the straps shown at B are connected. External receiving lines are connected to R and ground, and external sending lines are connected to T and ground, thus completing the circuits.

b. The current in the receive extension (REC EXT) is controlled by adjustment of

EXTENSION CURRENT control R110. There is no control over the send extension (SEND EXT) current during FULL DX—NORMAL operation because of the fixed tap on the send extension-current voltage divider (R132, R133, R134). Normally, the send extension current should read approximately +75 (deflection to right) on M101.

c. To obtain half-duplex in which the sending TT receives as well as transmits, SERVICE switch S102 is turned to HALF DX (center) position (fig. 18). The plate of receive extension driving tube V104 then is removed from the receive extension circuit and connected to the receiving selector magnet of the sending teletypewriter through the SEND

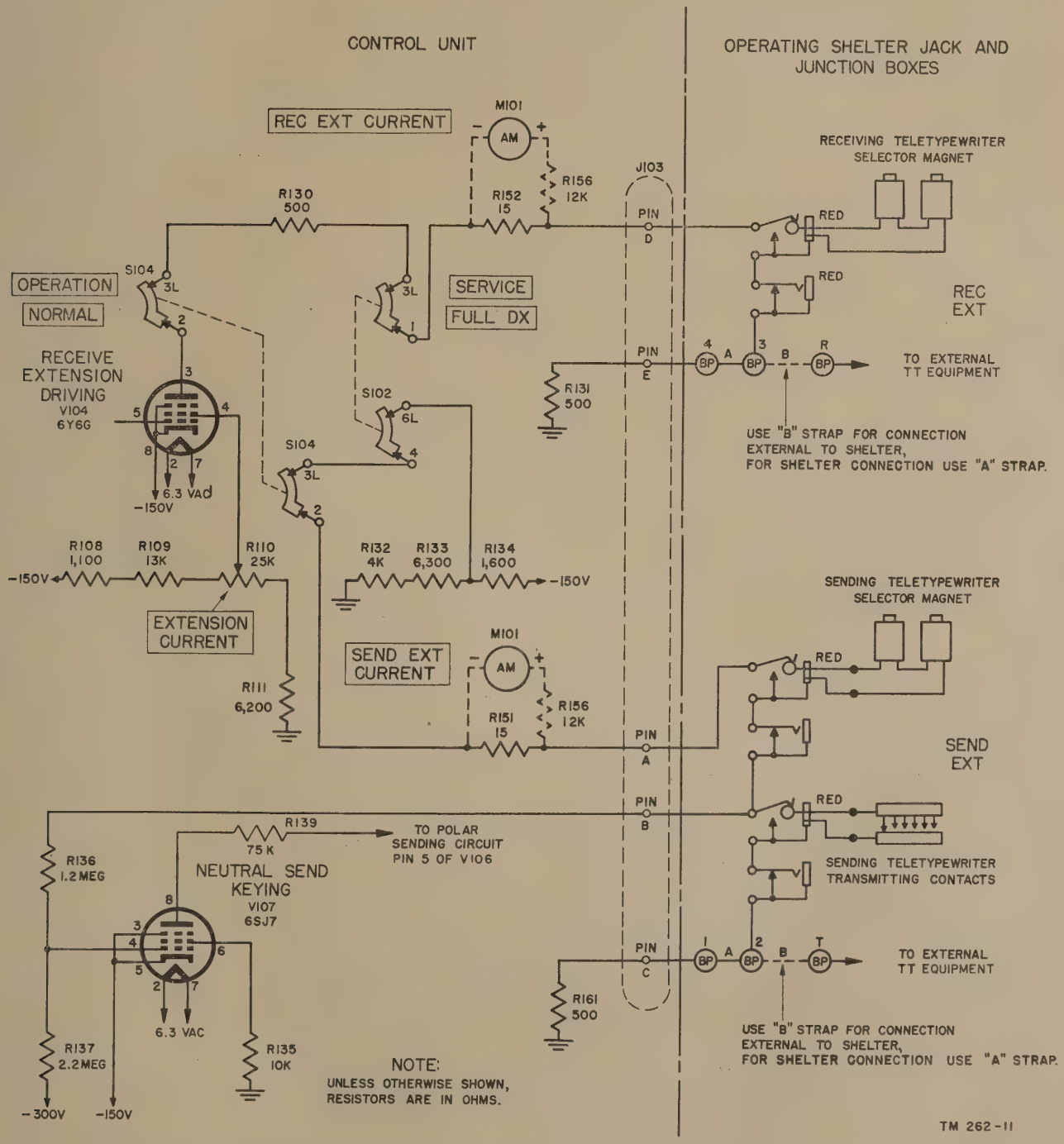


Figure 17. Schematic diagram of extension circuits arranged for full-duplex operation.

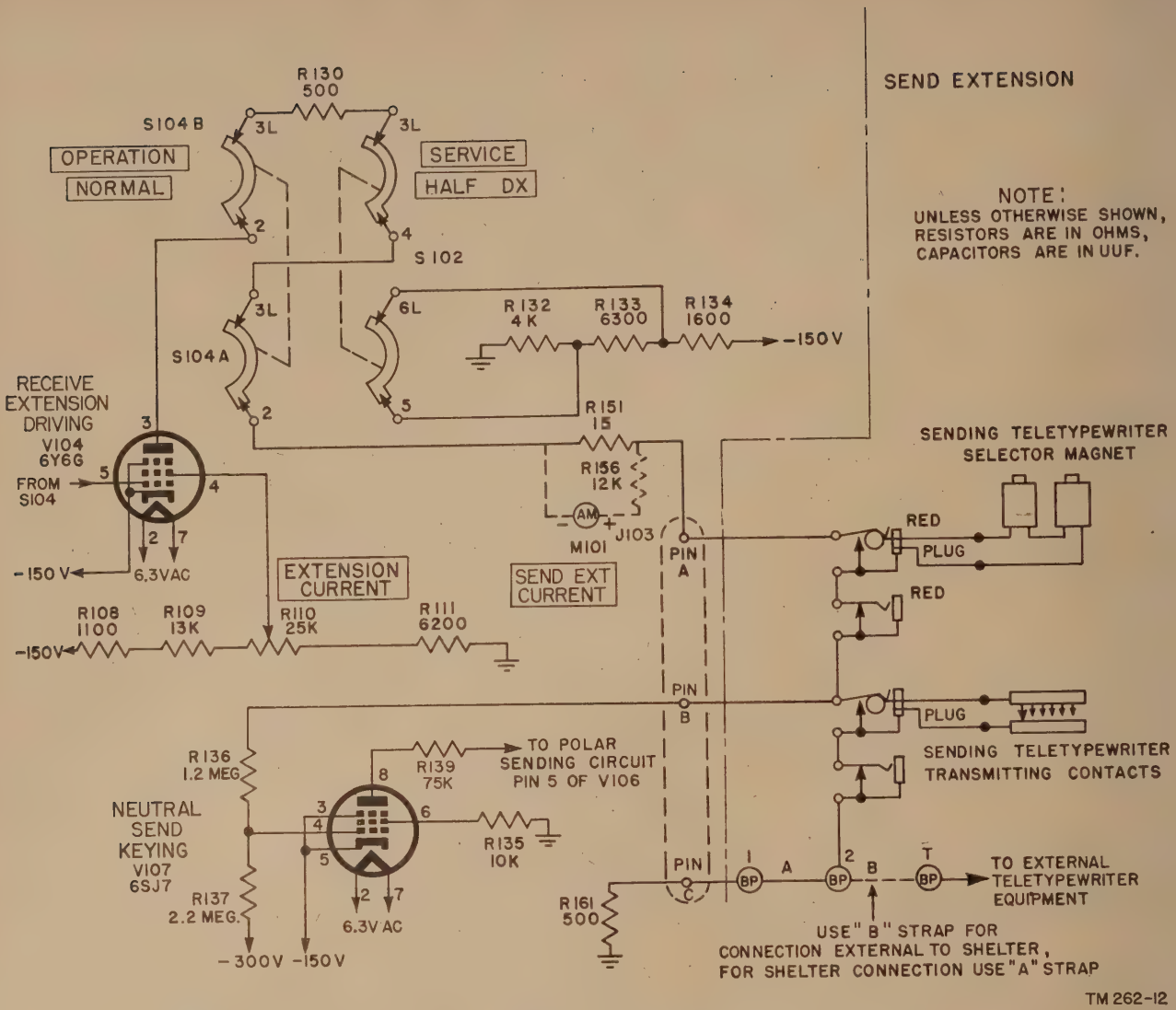


Figure 18. Extension circuit arranged for half-duplex or one-way reversible operation.

EXTENSION circuits. In this case current through the sending teletypewriter selector magnet is not fixed (as for full DX); it is controlled by adjustment of EXTENSION CURRENT control R110. One section of the S102 SERVICE switch shorts out R133 of the fixed REC EXT current divider, thus increasing current flow through the divider and compensating for the decrease in total current produced when only the SEND EXTENSION TT is used. When the extension is arranged for half-duplex service, the operator at the receiving terminal can interrupt the sender if necessary. To interrupt, the receiving operator opens the extension circuit at his end by operating the break key of the teletypewriter, transmitting a space signal to the distant terminal. Reception of the space signal cuts V104 off, interrupts current through the sending teletypewriter selector magnet, and prevents the sending teletypewriter from printing transmitted copy.

d. When the SERVICE switch is rotated to ONE WAY for one-way reversible operation, the extension circuit remains electrically the same as for HALF DX. However, when the SERVICE switch is in the ONE WAY position and the TRANSMITTER key is ON, keying circuits are closed which operate a relay in the tone oscillator of the receiving dual-diversity converter, as shown in figure 19. When this relay is energized, it applies a potential which controls receiver disabling relays in the two radio receivers used with the

dual-diversity converter. At the same time, the keying relay in the FS exciter is operated, applying power to the exciter unit tubes and connecting those circuits for sending. Transmission from an operating terminal can occur only when the TRANSMITTER switch of the control unit is ON. When the TRANSMITTER switch is in the *off* position, the keying relay in the FS exciter is deenergized and no r-f transmission occurs. At the same time, the relay in the dual-diversity converter is released, and again the two radio receivers are in a receiving condition. Break-in operation is not possible when the SERVICE switch is in the ONE WAY position.

34. Emergency FS Operation (fig. 20)

a. Emergency FS operation permits the transmitter to be keyed manually, and the transmitter frequency to be shifted for space signals, as in normal operation. In addition, this type of emergency operation allows the terminal to be used as an RTT relay station in which the received signals are retransmitted.

b. When the OPERATION switch on the control unit is turned to the EMERG FS position, the circuits are so arranged that the transmitter may be keyed from the receiving position. Figure 20 is a schematic diagram of the circuits arranged for emergency FS operation. The EMERG FS position of OPERATION switch S104 connects the control grid of receive extension driving tube V104 to the —150-volt supply which also is connected to the cathode. This connection holds V104 in a conducting state, preventing the receiving TT from running open (spacing continuously). In addition, this position of the OPERATION

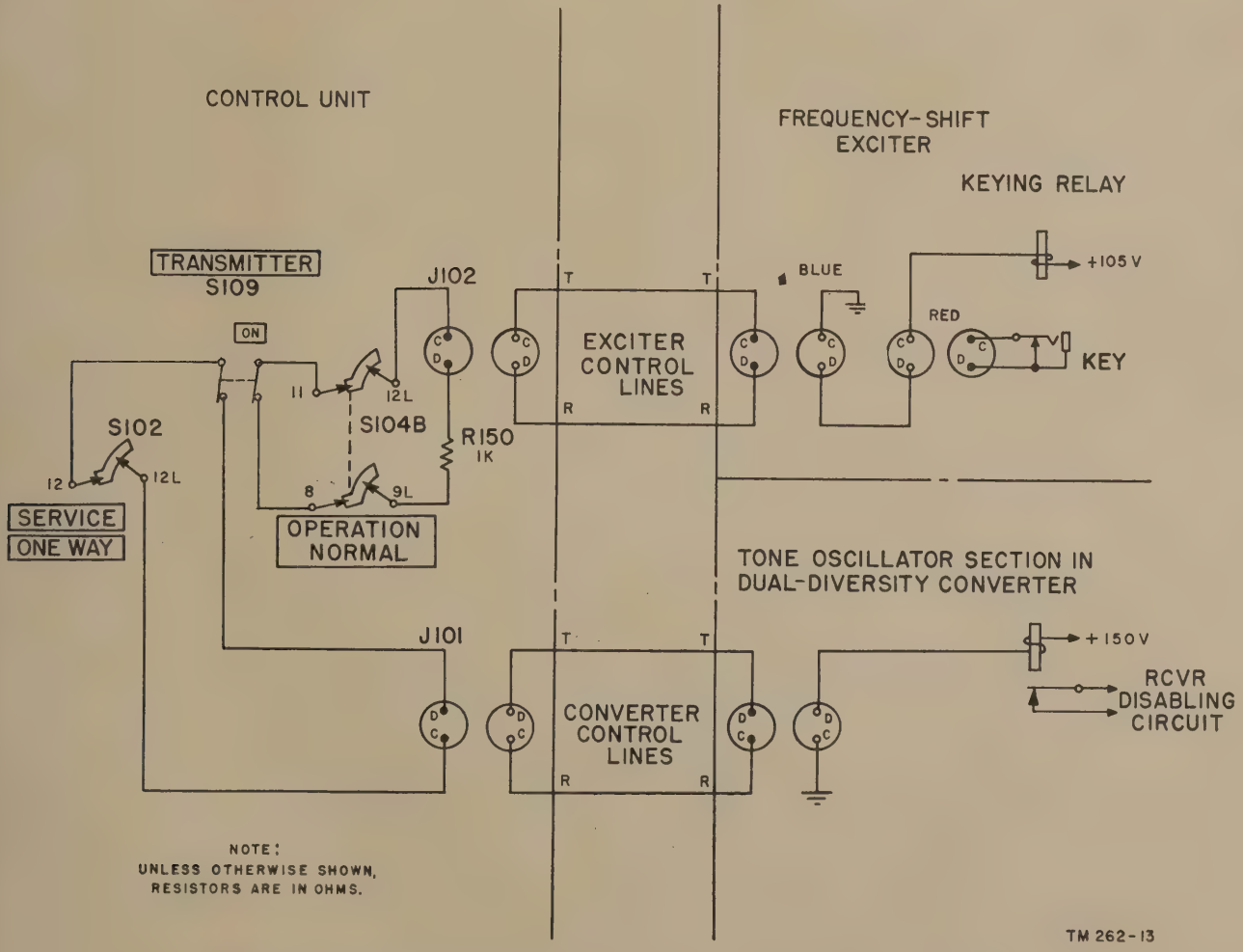


Figure 19. Control unit keying circuits for one-way reversible operation.

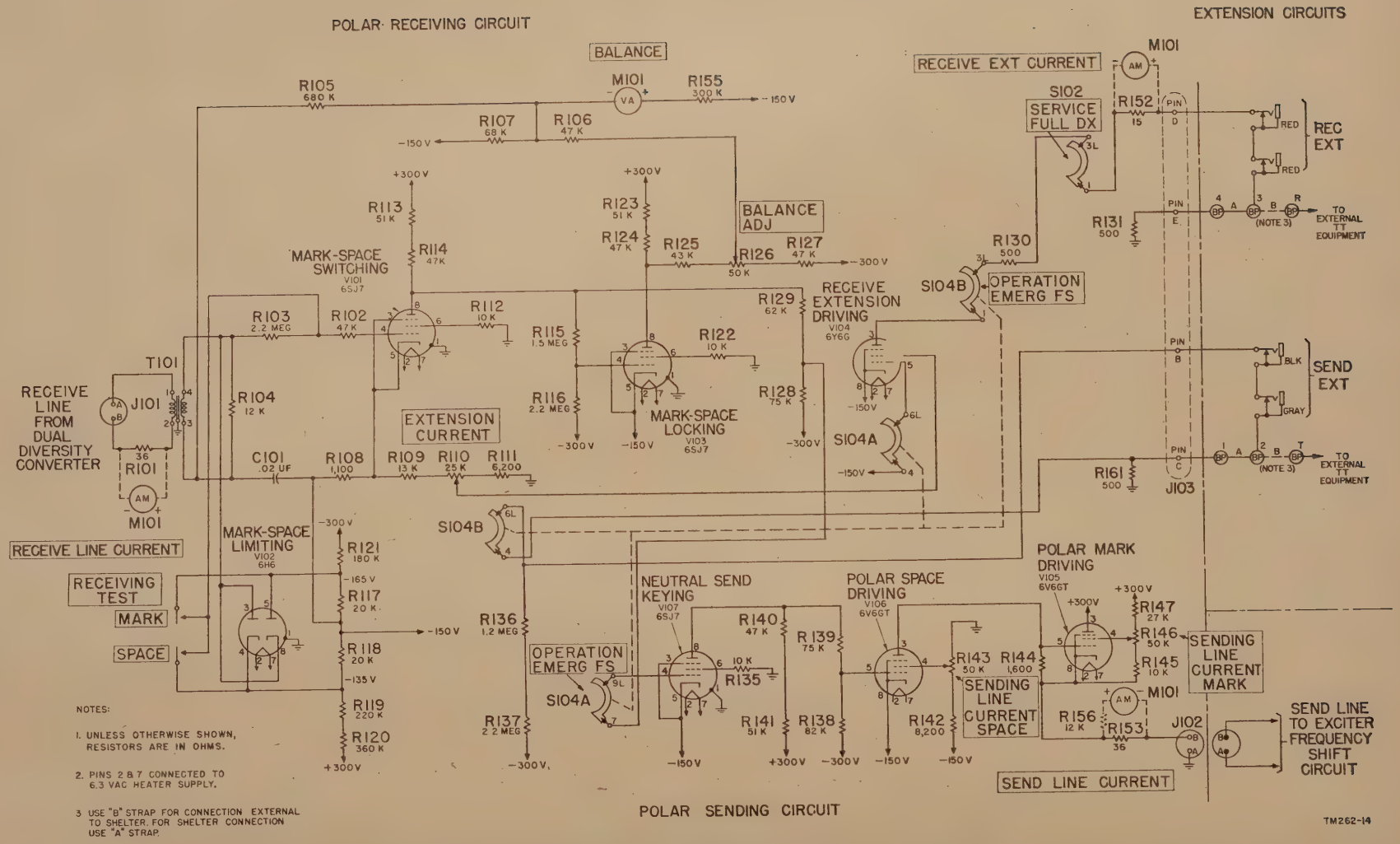


Figure 20. Control unit arranged for emergency FS operation.

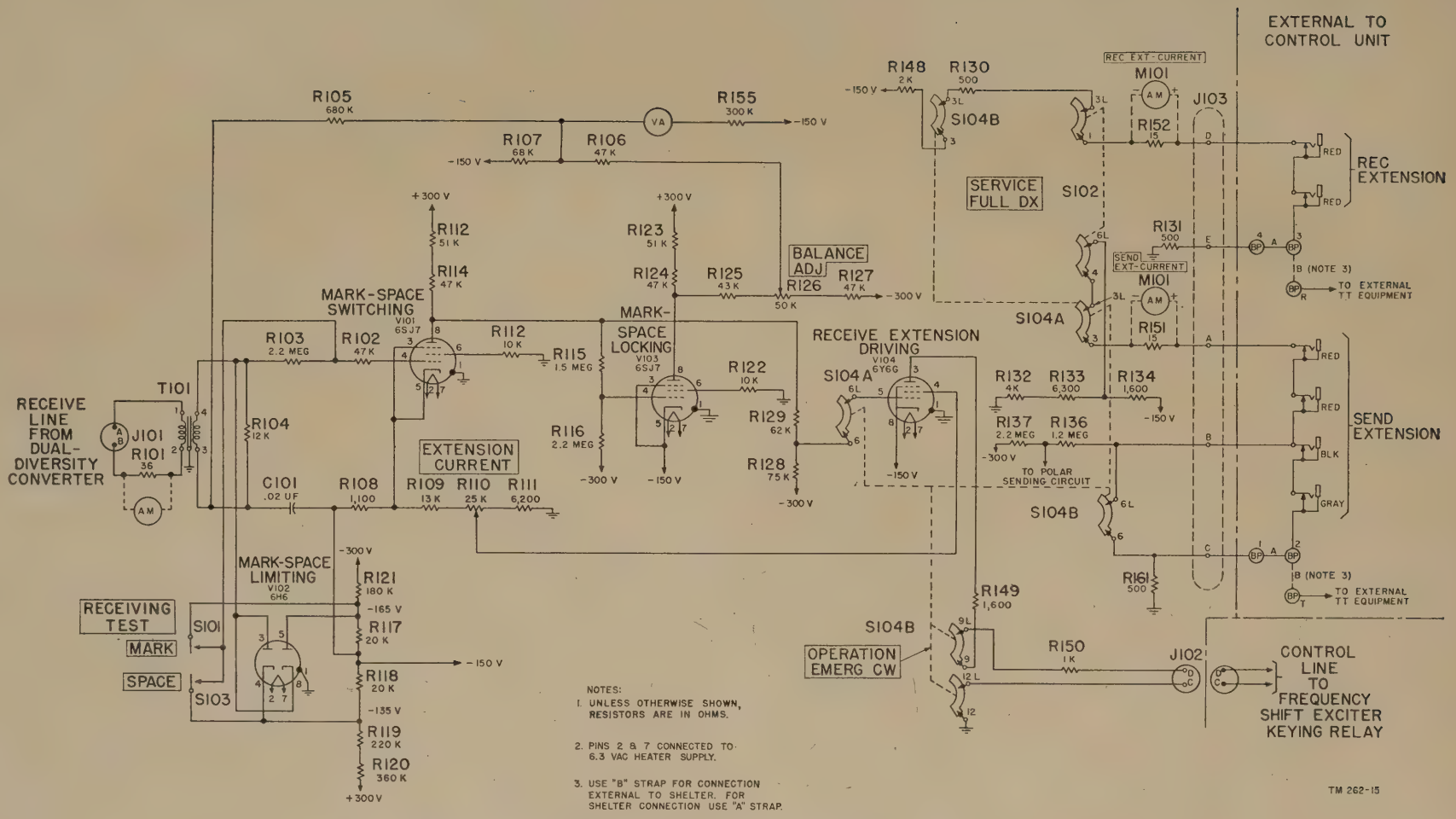


Figure 21. Control unit arranged for emergency c-w operation.

switch places a short circuit across the transmitting contacts of the sending teletypewriter, thus preventing the transmitting TT from operating.

c. The junction point between resistors R128 and R129 is connected to the control grid of neutral send keying tube V107 so that V107 is controlled by mark-space switching tube V101. When V101 conducts on a space signal from the dual-diversity converter, this tube cuts V107 off, causing the control unit sending circuit to produce a spacing signal at the FS exciter (par. 31). In similar manner, a mark signal from the dual-diversity converter causes the control unit sending circuit to produce a polar mark signal at the FS exciter.

d. When the RTT terminal equipment is used as a radio relay link, the signals from the dual-diversity converter line are the signals from the radio receivers. These received TT signals key the FS exciter. In this manner, signals received at the receiving section are retransmitted at the radio transmitter shelter.

35. Emergency C-W Keying
(figs. 21 and 22)

a. In emergency c-w keying operation, the transmitter carrier is interrupted as in normal radio code transmissions. When OPERATION switch S104 on the control unit is turned to EMERG CW position, and the OUTPUT knob on the dual-diversity converter is turned to the SPACE position, the radio transmitter carrier may be keyed from the receiving shelter. These manual signals are transmitted by the dual-diversity converter as polar signals which operate the sending circuit of the control unit, as shown in figure 21. A simplified diagram of the keying control circuit between the control unit and frequency shift exciter is shown in figure 22. With OPERATION switch in EMERG CW position, the plate of receive extension driving tube is connected, through resistor R149, through section A of OPERATION switch S104, and through resistor R150, over the control leads to the FS

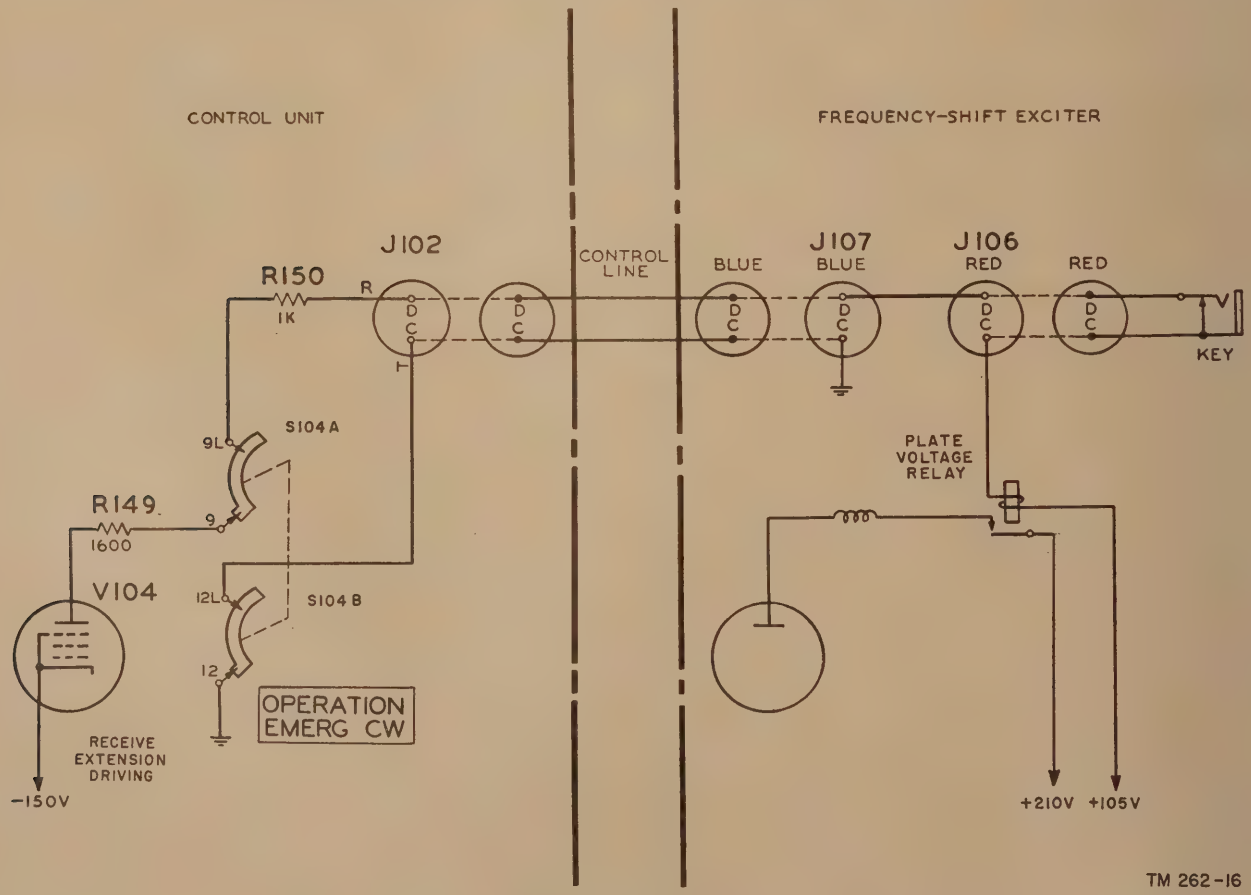


Figure 22. Keying control circuit for emergency operation.

exciter in the transmitting shelter. At the transmitting shelter, the control leads are connected, through jacks, to the normally closed contacts of the key jack and to one end of the exciter keying relay. The other end of the relay winding is connected to +105 volts on the FS exciter power-supply bleeder.

b. As an incoming mark signal is received from the dual-diversity converter, tube V104 conducts, causing current flow from the —150-volt supply, up through V104, through R149 and R150, and out over the line through the keying relay in the frequency shift exciter, and back to ground in the control unit. Thus, for a mark signal, the FS exciter is keyed and the transmitter produces an r-f signal. When a space signal is received from the dual-diversity converter, tube V104 is cut off, the keying relay in the frequency shift exciter is deenergized, and the transmitter is cut off.

36. Power Supply
(figs. 23 and 24)

a. The control unit power supply provides the a-c and d-c power required to energize and operate the tubes in the control unit. It also supplies current for the neutral and polar output loops. The power supply has three regulated rectifiers producing d-c outputs of —150 volts, —300 volts, and +300 volts with respect to the control unit chassis ground. The primary power supply to the rectifier transformers is applied through door interlocks S106 and S107, fuses F101 and F102, and AC SUPPLY switch S108. Provisions are made on transformers T102 and T103 for connections to either a 115- or a 230-volt single-phase supply.

b. The —150-volt supply uses V109 (a type 5R4GY tube) in a conventional full-wave rectifier circuit. The V109 rectifier plate voltage is supplied from transformer T103 secondary winding terminals 5–6–7, and the filament voltage is supplied from terminals 10–11. The unfiltered output of V109 is applied to filter capacitor C107 and to the plates of voltage regulator tubes V112 and V113 (type 6Y6G). The —150-volt output is regulated by control-

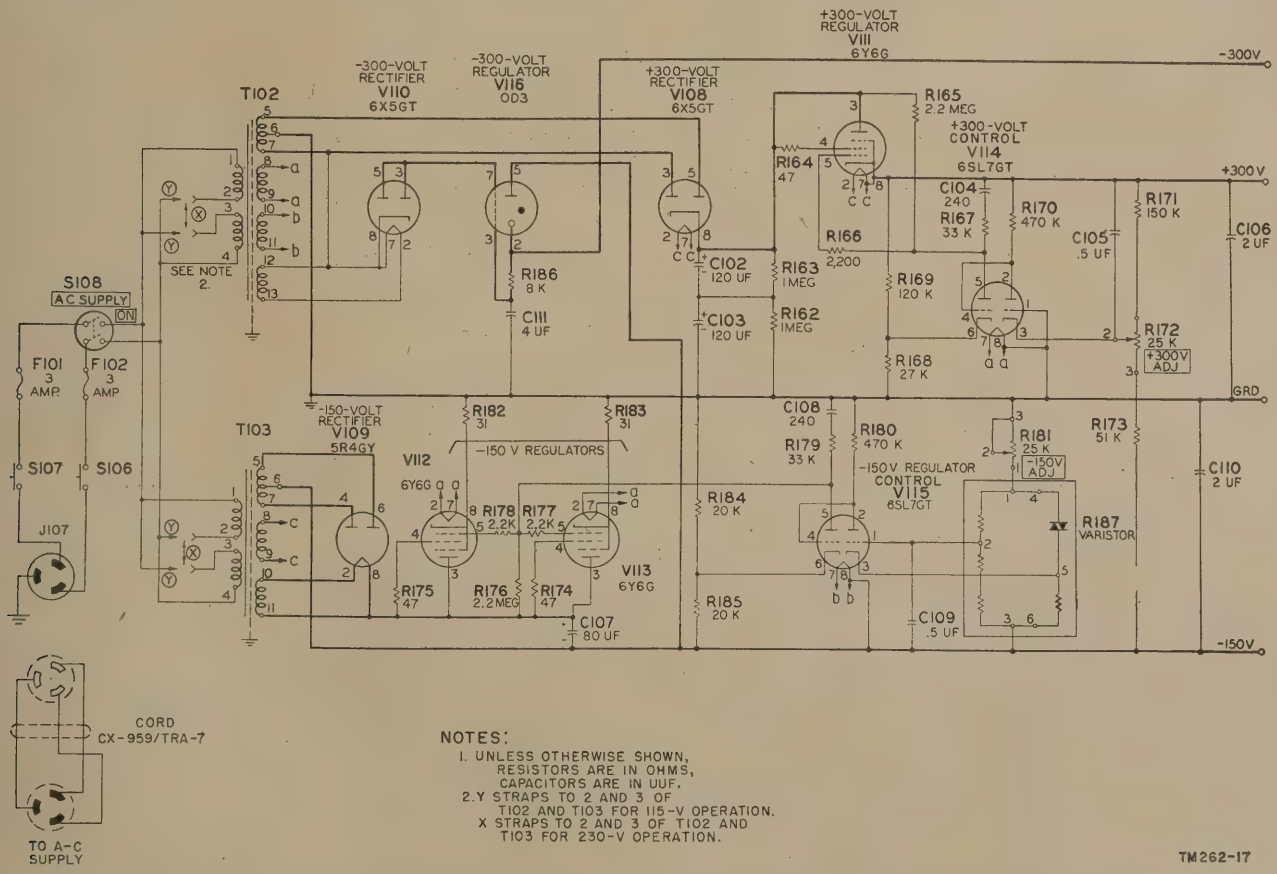


Figure 23. Control Unit C–292A/TRA–7, simplified schematic diagram of power supply.

ling the current through V112 and V113 and, consequently, the voltage drop across them. They are connected in series with the positive side of the output and are, in effect, an electronically controlled variable resistance. Changes in output voltage due to input-voltage or output-load variation are amplified by —150-volt regulator control tube V115, a type 6SL7. The circuit of V115 applies a controlling grid bias on the series regulator tubes V112 and V113. The voltage drop across these tubes either increases or decreases, and thus returns the output voltage to the correct regulated value.

c. Resistor bridge R187 is connected to maintain the proper control voltage at the grid of the pins 1, 2, 3 section of V115. This bridge is an unbalanced arrangement in which three legs of the bridge are conventional resistors while the fourth leg is a thyrite resistor (called a *varistor*), the resistance of which varies inversely as the impressed voltage. The thyrite resistor has a negative temperature coefficient of resistance (which means that its resistance varies inversely with temperature). To offset this and prevent false unbalance of the bridge, the leg diagonally opposite the thyrite resistor contains a nickel alloy resistor with a positive temperature coefficient of resistance. This resistor bridge is connected in series with the —150V ADJ control across the —150-volt output. If the voltage across the —150-volt output increases, the voltage applied across the thyrite also increases. Since the resistance of the thyrite then decreases, the voltage at terminal 5 of the bridge, and also at the pin 3 cathode of V115, rises in a positive direction (toward ground). The voltage at the pin 1 grid remains relatively constant and, as the cathode voltage changes, the effective grid voltage changes in a negative direction, reducing plate current flow through the pins 1, 2, 3 section of V115. Reduced plate current flow causes the pin 2 plate voltage to rise in a positive direction. But the pin 4 grid of the second section of V115 is connected to the pin 2 plate, and the pin 4 grid becomes more positive, producing increased plate current flow through the pins 4, 5, 6 section. This plate current flow, through resistor R176, reduces the voltage at the pin 5 plate of V115 and also at the grids of V112 and V113, which are attached to that point through resistors R177 and R178. The increased negative bias on the V112 and V113 grids increases the effective resistance of those tubes and reduces the —150-volt supply potential to the nominal operating value. If the output voltage decreases for any reason, it is regulated by the reverse action of that described above.

d. Resistors R177 and R178 suppress parasitic oscillations which otherwise might occur when the two tubes are connected in parallel. Resistors R174 and R175 also serve the same purpose. Resistors R184 and R185 form a voltage divider which is used to apply the proper cathode potential to the pins 4, 5, 6 section of V115. Resistors R182 and R183 provide a minimum cathode bias for V112 and V113. Capacitor C109 has a low impedance to output ripple voltage frequencies. V115 amplifies the ripple voltage applied to grid 1 and applies the resultant to the control grids of V112 and V113; this results in reducing the output ripple to a very small value despite the lack of a filter choke. Capacitor C109 (240 uuf (micromicrofarads)) and resistor R179 form a phase-shifting network which prevents low-frequency oscillation of the regulator circuit. Capacitor C110 is an output filter which acts as a low-impedance h-f (high-frequency) shunt across the rectifier output. The heater voltage for V112 and V113 is taken from a separate winding on T102. The heater voltage for V115 also is taken from a separate winding on T102.

e. In Control Unit C–292B/TRA–7, the varistor bridge circuit has been eliminated and another bridge circuit is substituted. This circuit uses V117, a type OC3 voltage regulator tube, in place of thyrite resistor (figs. 24 and 33). The voltage regulator (voltage reference stage) tube has the same general characteristic as the thyrite; that is, as the applied voltage is increased, the resistance decreases. As the output voltage changes, the current flow through V117 and also R190 changes. This change increases or decreases the cathode voltage of the pins 1, 2, 3 section of —150-volt control tube V115, producing the same regulating action as described above.

f. The +300-volt supply (fig. 23) operates as follows:

(1) The +300-volt supply uses V108 (a type 6X5GT tube) as a full-wave

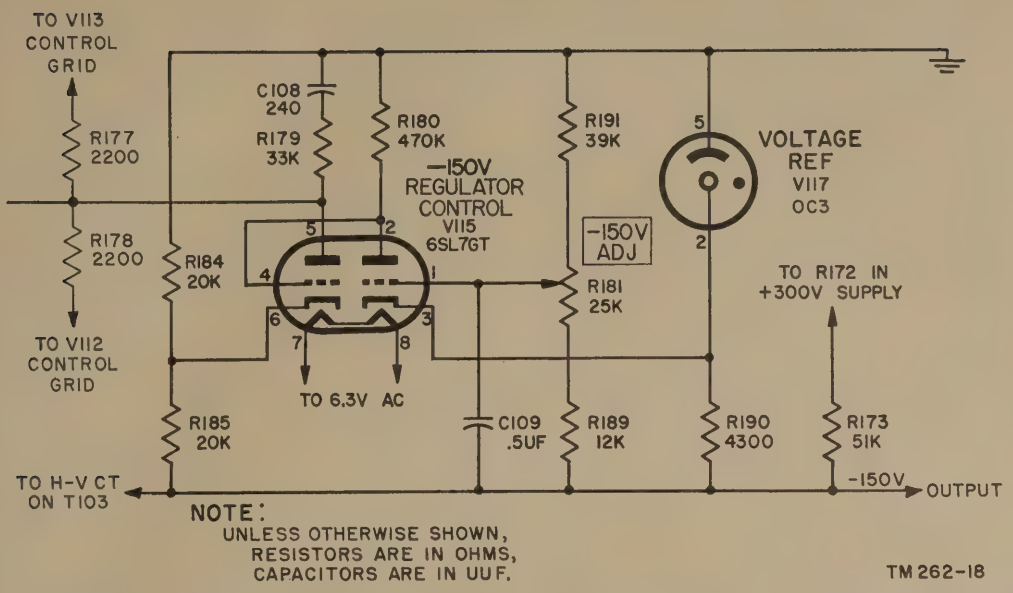


Figure 24. Control Unit C-292B/TRA-7, simplified schematic diagram of change in power supply.

rectifier. The V108 a-c plate voltage is supplied from transformer T102 terminals 5, 6, and 7 secondary. The V108 heater voltage is obtained from the terminals 8 and 9 secondary of T103. The unfiltered output of V108 is applied to capacitors C102 and C103, which are in series. Resistors R162 and R163 (1 megohm each) are high-resistance bleeder resistors which serve to drain the charge from the capacitors when the equipment is shut off. These resistors also equalize the voltages across C102 and C103 during operation.

(2) The output voltage of the +300-volt supply is regulated in a manner similar to that previously described for the —150-volt supply. The +300-volt output is regulated by controlling the current through regulator tube V111 (a type 6Y6G) which is in series with the positive side of the supply. Changes in output voltage affect regulator control tube V114 (a type 6SL7) which amplifies the changes and adjusts the grid voltage of V111 to compensate for the variation in output voltage. The pin 3 cathode of V114 is connected to the center arm of +300V ADJ control R172. Potentiometer R172 is in series with R171 and R173 across the combined +300-volt and —150-volt supplies, putting a total of 450 volts across the divider formed by these resistors.

(3) The voltage at the variable tap on resistor R172 varies in proportion to the voltage variations across the potentiometer and, since the —150-volt output is regulated, it varies in proportion to the +300-volt output variations. This voltage is applied to cathode 3 of amplifier tube V114. Grid 1 of tube V114 is grounded and the tap on potentiometer R172 is adjusted to maintain cathode 3 a few volts positive with respect to the grounded grid to give a negative grid bias.

(4) When the voltage across the +300-volt output terminals increases, either due to an increase in input voltage or a decrease in load, it will result in a small increase in positive voltage on cathode 3 of tube V114. Since grid 1 of tube V114 is grounded, the negative bias will increase and reduce the plate 2 current and the drop across resistor R170. This will give a more positive voltage on grid 4 of V114. The change in voltage on cathode 6 of V114 is negligible com-

pared with the change on grid 4 so the negative grid bias is reduced. This increases the plate 5 circuit current, the voltage drop across resistor R165 and, in turn, the negative grid bias on tube V111 just enough to reduce the +300-volt output to the regulated value. A decrease in voltage across the output terminals has the opposite effect.

(5) Resistor R164 is in the screen-grid circuit to prevent oscillation and to suppress parasitics. Resistor R165 is the plate load for the pins 4, 5, 6 section of V114. Resistor R166 limits the V111 grid current in the event that the grid becomes positive. Resistor R167 and capacitor C104 form a phase-shifting circuit to prevent tube V114 from oscillating. Resistors R168 and R169 act as a voltage divider to furnish the correct voltage on cathode 6 of tube V114.

(6) Capacitor C105 has a low impedance to output ripple voltage. It applies ripple voltage changes in the output to cathode 3. These changes are amplified by tube V114 and applied to control grid 5 of tube V11 to reduce ripple in the output to a small value. Capacitor C106 provides a low-impedance shunt to h-f voltages (due to the square waves in the receiving and sending tubes) which may appear across the output.

g. The —300-volt supply uses V110 (a type 6X5GT tube) as a half-wave rectifier by connecting the two plates (pins 3 and 5) together. Electron flow is from terminal 7 of T102 to the cathode (pin 8) of V110, then through V110 to the plates. The current then flows through pins 7 and 3 of V116, through R186, out through the load to ground, and then back to terminal 6 of T102. Heater voltage for V110 is obtained from the isolated terminals, 12 and 13, winding of T102. The rectified negative voltage from the plates of —300-volt rectifier V110 is applied, through a voltage-regulating circuit, in series with the —150-volt supply. The voltage-regulating circuit consists of R186 in series with V116 (a type OD3 tube), a gaseous regulator which maintains a constant potential of approximately 150 volts between its active pin 2 and 5 terminals. The characteristics of V116 are such that as the applied voltage across the tube is reduced, the tube draws less current, and as the applied voltage is increased, the tube draws more current. As the —300-volt load becomes heavier and current drain through R186 increases, the voltage drop across R116 decreases, causing the resistance of V116 to increase and maintain the voltage at pin 2 at a constant level. To prevent the output voltage from becoming excessive if V116 is removed from its socket, connections are made to the plates of V110 through internal connections to pins 7 and 3 of V116. When V116 is removed, the —300-volt circuit is broken. Filter capacitor C111 (4 uf) is connected on the load side of the internal tube jumper so that it can bleed off through the load.

CHAPTER 4

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages can be dangerous and fatal. When it is necessary to measure high voltages, observe the following rules: First, connect the proper voltmeter lead to the circuit ground. Then, place one hand in your pocket. This will eliminate the possibility of making accidental contact with another part of the circuit, thus making it impossible for the electricity to travel from one hand to another through the body. If the voltage is less than 300 volts, connect the remaining test lead to the hot terminal (which may be either positive or negative with respect to ground). If the voltage is greater than 300 volts, shut off the power, connect the hot lead, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points, both of which are at some potential with respect to ground. Before touching any part after the voltage is shut off, short the part to ground.

37. Trouble Shooting Procedures

The first step in trouble shooting a defective unit is sectionalize the fault. To sectionalize means to trace the fault to the *major circuit* responsible for the abnormal operation of the equipment. The second trouble shooting step is to localize the fault. To localize means to trace the fault to the defective *part* responsible for the abnormal operation. Some faults, such as burned-out resistors, r-f arcing, and shorted transformers, often can be located by sight, smell, and hearing. The majority of troubles, however, must be located by checking voltage and resistance and comparing the observed results with the voltage and resistance charts.

38. Test Equipment Required for Trouble Shooting

The test equipment required for trouble shooting Control Unit C–292(*)/TRA–7 is listed below. The technical manuals associated with the test equipment also are indicated.

Test equipment	Technical manual
Tube Tester I–177 or Tube Tester TV-3/U.	TM 11–2627 NAV SHIPS 91, 254
Multimeter TS–389/U or Electronic Multimeter TS–505/U.	TM 11–2673 TM 11–5511
Signal Generator SG–15/PCM..	TM 11–2096
Signal Generator I–72.....	TM 11–307 and TM 11–4052
Oscilloscope OS–8A/U.....	NAV SHIPS 91, 272
Decibel Meters TS–399/U.....	TM 11–2045
Frequency Meter Set SCR–211–(*).	TM 11–300

39. Visual Inspection

a. Failure of the equipment to operate properly usually will be caused by one or more of the following faults:

(1) Defective power cable.
(2) Worn, broken, or disconnected cords or plugs.
(3) Burned-out fuses.
(4) Wires broken because of excessive vibration.
(5) Loose or defective tubes.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before dis-

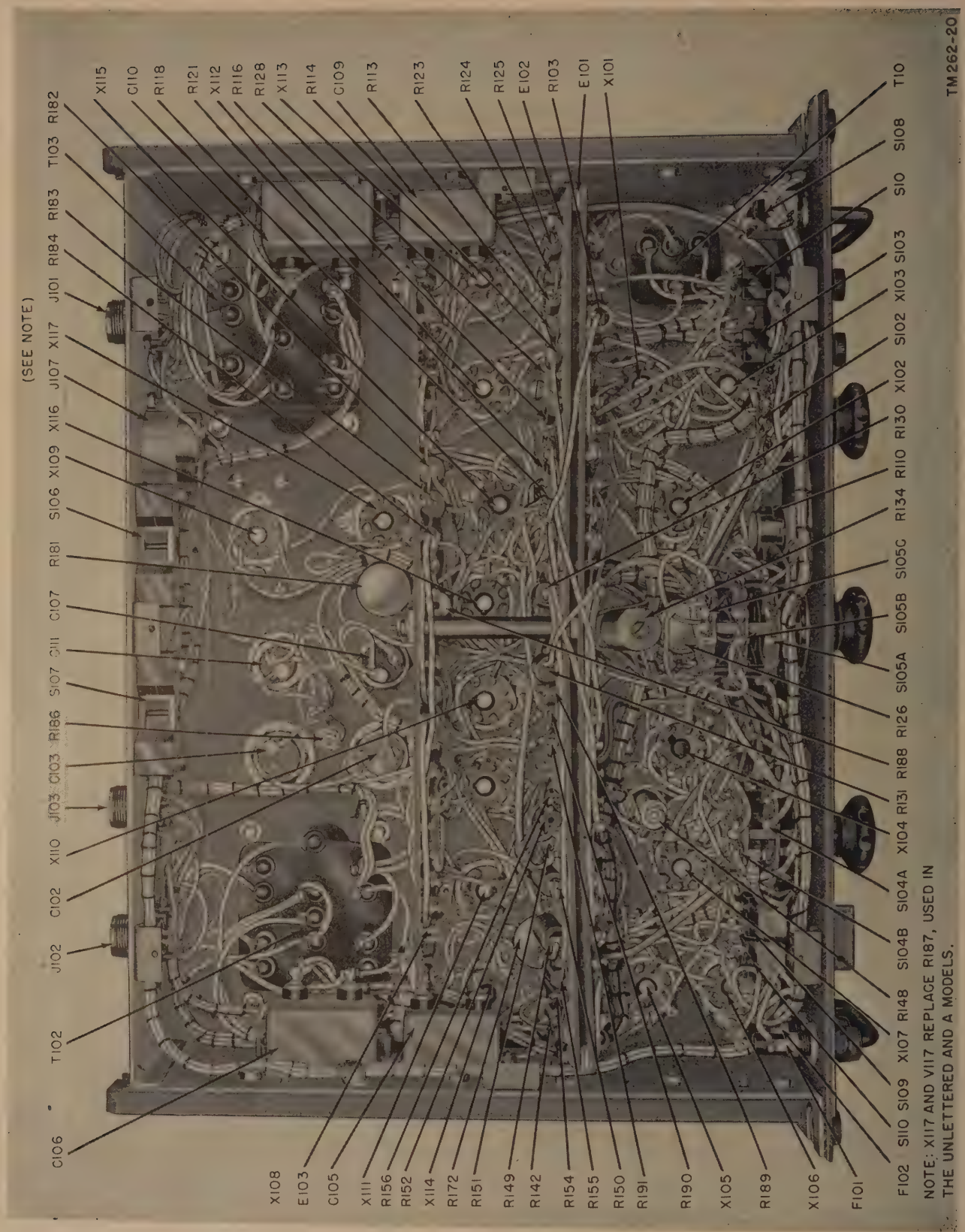


Figure 25. Control Unit C–292B/TRA–7, bottom view of chassis.

assembling the equipment for detailed examination. If possible, obtain information from the operator regarding performance at the time trouble occurred.

40. Checking B+ Circuits for Shorts

Trouble within the control unit often may be detected by checking the resistance of the h-v (high-voltage) circuits to ground before applying power to the equipment, thus preventing damage to the power supply. Make the following checks at the bottoms of the tube sockets (figs. 25 and 27) before attempting to put the unit in operation. Leave the main power cable disconnected and disconnect any extension circuits that may have battery applied at the other end. Remove the bottom cover plate; replace it after the measurements are made (if everything checks correctly). If the resistance is zero or unusually low in any of the measurements below, check the input and output filter capacitors for the faulty circuit.

a. The resistance between pin 8 of rectifier tube V109 and ground should be approximately 3 megohms.

b. The resistance between pin 5 of regulator tube V116 and ground should be 5,600 ohms.

c. The resistance between pin 3 of V116 and ground should be about 70,000 ohms.

d. The resistance between pin 8 of rectifier tube V108 and ground should be approximately 1 megohm.

e. The resistance between pin 8 of regulator tube V111 and ground should be about 50,000 ohms.

41. Test Set-Up and Operational Checks

a. Test Set-Up. A bench check of the control unit for observation and determination of faulty operation can be accomplished with a minimum of equipment and parts. The test set-up outlined in figure 26 is required. The three resistors, the SPST (single-pole, single-throw) switch, the DPDT (double-pole, double-throw) switch, the rheostat, the 6-volt battery (capable of supplying 25 ma), the voltmeter, and the ohmmeter should be connected to jacks J101 through J103 on the rear of the control unit. By removing and reconnecting the leads, one multimeter may be used in place of the ohmmeter and the voltmeter. The leads connecting the test set-up components to their respective jack pins may be soldered to spare plugs to fit the jacks, or connected in any other convenient manner.

b. Circuit Loads. The resistors take the place of the normal loads on the control unit circuits so that operational checks may be performed on the bench. During control unit operational checks, observation of the front panel meter will provide an indication of correct (or faulty) operation. The checks below will produce the results indicated, provided the equipment is in the proper working order. If one of the checks show a malfunctioning in a circuit, refer to the trouble shooting chart in paragraph 42.

c. Front Panel Control Settings. After the test resistors and the SPST switch test connections (fig. 26) have been made to J102 and J103, connect the primary power cable to J107 on the rear of the control unit and to a 115-volt, 60-cycle primary power source. Set the front panel controls (fig. 4) as follows:

(1) Throw the AC SUPPLY toggle switch on the front panel to the ON position. The white AC SUPPLY indicator lamp should light.

(2) Throw the TRANSMITTER switch to the ON position. The green TRANSMITTER indicator lamp should light.

(3) Turn the SERVICE switch to the FULL DX position.

(4) Turn the OPERATION switch to the NORMAL position.

(5) Turn the EXTENSION CURRENT knob to maximum counterclockwise position.

(6) Turn the SENDING LINE CURRENT SPACE and MARK knobs to maximum counterclockwise positions.

d. Voltage Checks. Before proceeding with the operational check, make the following voltage checks:

(1) Turn the METER switch to the —150 VOLT SUPPLY position. The meter should indicate —75 ±5 to the left of zero center. If the reading is not within these limits, raise the top cover of the unit and adjust the slotted shaft of the —150 V ADJ

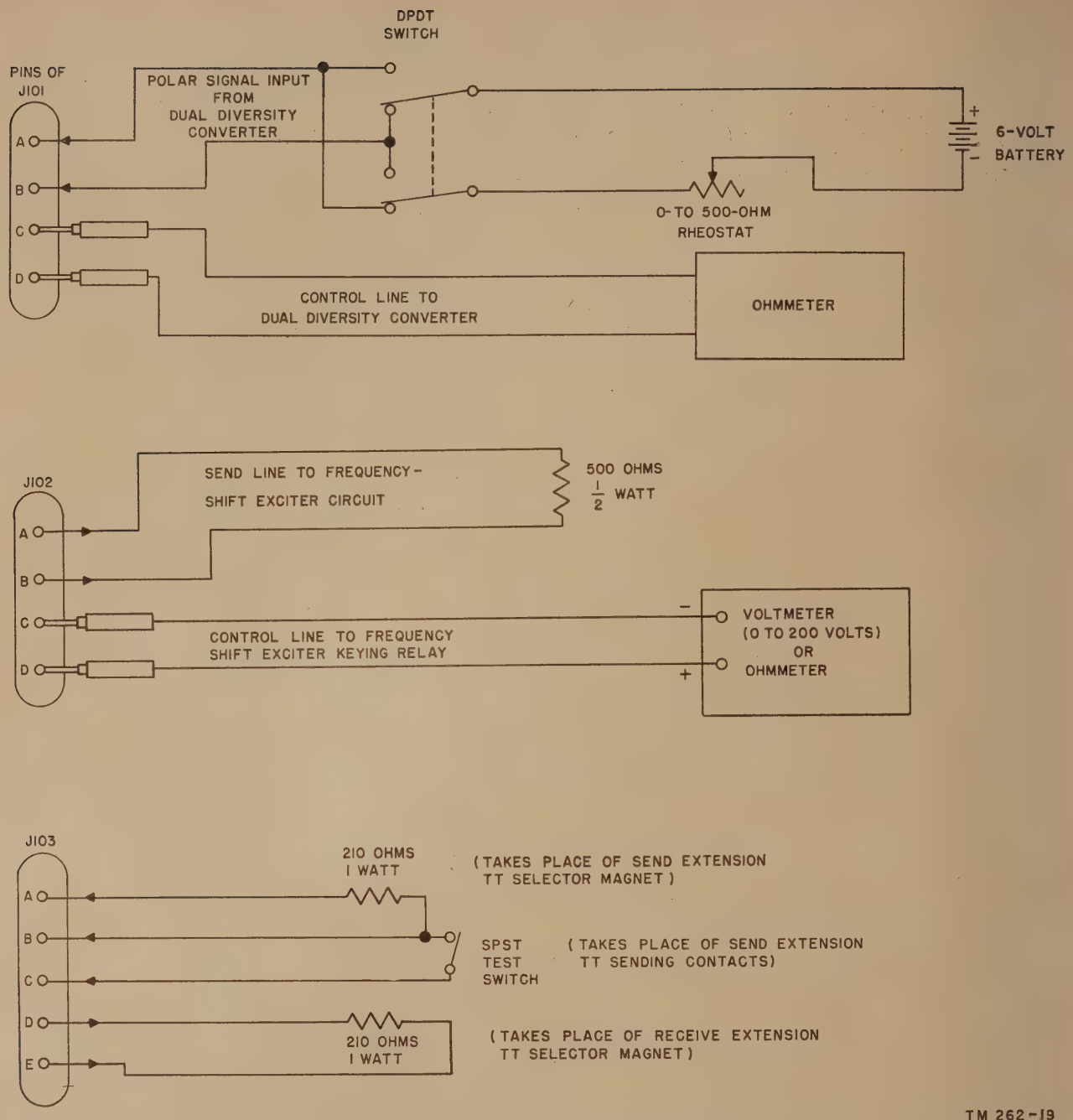


Figure 26. Test set-up for control unit.

control (fig. 5) to obtain the correct meter reading.

(2) Turn the METER switch to the +300-VOLT SUPPLY position. The meter should indicate +75 ±5 to the right of zero center. If the reading is not within these limits, raise the top cover on the control unit and adjust the slotted shaft of the +300 V ADJ control (fig. 5) until the meter pointer indicates the desired setting.

(3) Turn the METER switch to the —300 VOLT SUPPLY position. The meter should indicate between —65 to —85 to the left of zero center. No adjustment of this supply is provided, and if the reading is not within these

limits, see the trouble shooting chart (par. 42) for possible causes and correction.

e. Receiving Circuit and Receive Extension Test. This check serves to test the operating condition of both the receiving circuit operated by polar input signals, and the receive extension (REC EXT) circuits which connect to the selector magnets of the receiving teletypewriters.

(1) Check to see that the AC SUPPLY switch is ON, the TRANSMITTER switch is ON, the SERVICE switch is in FULL DX position, and the OPERATION switch is in NORMAL position.
(2) Check to see that the SPST test switch (fig. 26) is closed (on).
(3) Turn the front panel METER knob to REC EXT CURRENT.
(4) Press the RECEIVING TEST MARK button on the front panel of the unit.
(5) Adjust the EXTENSION CURRENT control until the meter indicates +75 to the right of zero center. Release button.
(6) Press the RECEIVING TEST SPACE button. The meter should indicate zero. Release button.
(7) Turn METER switch to BALANCE.
(8) Raise lid on control unit and, with a screwdriver, adjust the BALANCE ADJ potentiometer while alternately pressing the RECEIVING TEST MARK and SPACE buttons. Continue this adjustment until the meter pointer swings to the same dial reading to the left and right of zero center. This reading should be between 70 and 80 when adjustment is finished.

f. Sending Circuit and Send Extension Test. This test serves to check both the control unit polar sending circuit which transmits signals to the frequency-shift exciter and the send extension current which normally flows through the sending teletypewriter selector magnet and transmitting contacts during full-duplex, half-duplex, and one-way operation.

(1) Check that the AC SUPPLY switch is ON, the TRANSMITTER switch is ON, the SERVICE switch is in FULL DX position, and the OPERATION switch is in the NORMAL position.
(2) Turn the METER knob to the SEND LINE CURRENT position.
(3) Make sure that the SPST test switch (fig. 26) is in the closed position.
(4) Adjust the SENDING LINE CURRENT MARK control until the panel meter indicates +60 to the right of zero center.
(5) Throw the SPST test switch to the open position. This simulates depressing the break key on the sending teletypewriter.
(6) Adjust the SENDING LINE CURRENT SPACE control until the panel meter indicates —75 to the left of zero center.
(7) Turn the METER switch knob to the SEND EXT CURRENT position. The meter should read zero.
(8) Throw the SPST test switch to the closed position. The meter should read between +65 and +85 to right of zero center. In full-duplex operation this SEND EXT CURRENT is not adjustable.
(9) Turn the SERVICE switch first to HALF DX then to ONE WAY. In both positions the SEND EXT CURRENT is controlled by EXTENSION CURRENT potentiometer and should be adjusted to +75 to the right of zero center on meter.

g. Control Circuit Tests. The operation of the control unit circuits which affect the keying relays in the frequency-shift exciter and the dual-diversity converter are checked as follows:

Caution: To avoid damage to the test instruments used, perform checks in the order indicated.

(1) *Control line circuit to FS exciter keying relay, emergency c-w operation.*
(*a*) Turn the OPERATION switch to EMERG CW and turn the SERVICE switch to FULL DX.
(*b*) Set the test voltmeter to a scale greater than 150 volts. Connect the leads to the meter.
(*c*) Apply the positive test lead prod to

pin D of J102 and apply the negative test lead prod to pin C of J102. The voltmeter should read zero.

(*d*) Press the RECEIVING TEST MARK button. The voltmeter should indicate approximately 150 volts. Release the test button.

(2) *Control line circuit to FS exciter keying relay, normal, and emergency FS operation.*

(*a*) Check to see that the SERVICE switch is on FULL DX.

(*b*) Turn OPERATION switch to NORMAL and throw the TRANSMITTER switch to ON.

(*c*) Obtain a test ohmmeter and connect one test lead to pin D and the other lead to pin C of J102.

(*d*) With the OPERATION switch at NORMAL, the resistance between pins C and D of J102 should be 1,000 ohms.

(*e*) Rotate the OPERATION switch to EMERG FS. The resistance should be 1,000 ohms.

(3) *Control circuit to FS exciter keying relay and dual-diversity disabling relay, one-way reversible operation.*

(*a*) Rotate the SERVICE switch to ONE WAY.

(*b*) Check that the OPERATION switch is on NORMAL.

(*c*) Check that the ohmmeter test leads are connected to pins C and D of J102.

(*d*) Throw the TRANSMITTER switch to ON. Resistance should be 1,000 ohms. Throw the TRANSMITTER switch to the *off* position. Resistance should read infinity. This checks the FS exciter keying control circuit.

(*e*) Remove the ohmmeter test leads and connect them to pins C and D of jack J101.

(*f*) Throw the TRANSMITTER switch to ON. Resistance should be zero. Throw the TRANSMITTER switch to the *off* position. The meter should read infinity. This checks the dual-diversity converter relay control circuit.

h. Operating Check. After the above checks have been made, an operating check of the control unit input circuit should be made. It is possible to make this check by means of resistance measurements, but occasionally trouble will occur in the input transformer which will produce faulty operation, but which will not be indicated by a continuity test. For this reason an adjustable source of d-c voltage is required to provide the 25-ma marking or spacing current for the input circuit. For example, in figure 26 a 6-volt battery in series with a 0- to 500-ohm rheostat is connected to a DPDT switch. Reversal of the switch position reverses current flow through the input circuit, thus simulating polar mark and space signal transitions. To perform the control unit input circuit test, proceed as follows (the control unit should be energized):

(1) Set the adjustable voltage control rheostat (fig. 26) so that maximum resistance is in the circuit.

(2) Check to see that one of the leads from the adjustable voltage source goes to pin A of J101 and that the other goes to pin B of J101.

(3) Set the SERVICE switch to FULL DX and set the OPERATION switch to NORMAL.

(4) Turn the METER switch to REC LINE CURRENT.

(5) Decrease the resistance of the input voltage control rheostat until the panel meter reads 75 on either side of zero center. If the meter needle swings to the right of center, mark signal current is flowing through the input transformer primary. If the needle swings to the left of center, space signal current is flowing. Set the DPDT test circuit switch so that the mark signal current is present.

(6) Turn the METER switch to the REC EXT CURRENT position.

(7) Throw the DPDT test switch to space position. The meter should read zero.

(8) Throw the DPDT test switch to the mark position. The meter should read +75 to the right of zero center. Throw the DPDT test switch back and forth several times; REC EXT CURRENT should always be zero for

a space signal and +75 for a mark signal.

42. Trouble-shooting Charts

When the indicated results are not obtained during one or more of the operational checks described in paragraph 41, consult the trouble-shooting charts below. Connections to J103, to pins A and B of J102, and to pins A and B of J101 are made as shown in figure 26. It is not necessary to make any connection to pins C and D of J101 and pins C and D of J102.

a. Full-Duplex Operation. When using the trouble-shooting chart below, turn the AC SUPPLY switch ON, turn the SERVICE switch to FULL DX, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch to ON. The other controls are set or adjusted as indicated in the *Symptom* column.

Symptom	Probable trouble	Corrections
Unequal meter deflections, METER knob on BALANCE.	Feedback voltages unequal.	Check plate voltage of tube V103 and d–c voltage at junction of resistors R106 and R107. Replace defective parts.
	Faulty diode in V102.	Replace tube V102.
	Faulty capacitor C101.	Replace capacitor C101.
No meter indication with METER knob on REC EXT CURRENT.	No positive voltage on grid of tube V104.	Check plate voltage of tube V101 and grid to cathode voltage on tube V104. Replace defective parts.
	Defective tube V104.	Replace tube V104.
	Open plate circuit of tube V104.	Check continuity through SERVICE and OPERATION switches and resistors R130 and R131 from pin 3 of tube V104. Replace defective parts or restore continuity of circuit.
No control when turning EXTENSION CURRENT knob.	Incorrect screen voltage on tube V104.	Check resistors R108 through R111 and replace defective parts.
No meter indication with METER knob on SEND EXT CURRENT.	Open resistor in voltage divider.	Check resistors R132, R133, and R134. Replace defective parts or restore continuity of circuit.
No meter indication with METER knob on SEND LINE CURRENT and mark signal being transmitted.	Open resistor R147.	Check continuity of R147 and replace if defective.
	Defective tube V105.	Replace tube V105.
	No plate voltage on tube V105.	Check continuity of leads to plate of tube V105.
No control when turning SENDING LINE CURRENT MARK knob.	Incorrect screen voltage on tube V105.	Check resistors R145, R146, and R147. Replace defective parts.
	Incorrect plate voltage on tube V106.	Check plate voltage on tube V106 and resistor R144. Replace defective parts.
No meter indication with METER knob on SEND LINE CURRENT and space signal being transmitted.	Plate resistor R144 open.	Replace.
	No plate voltage on tube V106.	Replace defective parts.
	No grid voltage on tube V106.	Check plate voltage of tube V105 and tube V107. Replace if defective.
No control when turning SENDING LINE CURRENT SPACE knob.	Incorrect screen voltage on tube V106.	Replace resistors R142 or R143 if defective.

Symptom	Probable trouble	Corrections
No meter indication with METER knob on REC LINE CURRENT.	Primary of transformer T101 open.	Check continuity and replace defective parts.

b. Half-Duplex Operation. When using the trouble-shooting chart below, turn the SERVICE switch to HALF DX, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch to ON.

Symptom	Probable trouble	Corrections
Unequal meter deflections, METER knob on BALANCE.	Mark-space locking circuits output voltages unequal.	Check plate voltage of tube V103 and d-c voltage at junction of resistors R106 and R107. Replace defective parts.
	Faulty diode in tube V102.	Replace tube V102.
	Faulty capacitor C101.	Replace capacitor C101.
No meter indication with METER knob on SEND EXT CURRENT.	No positive grid voltage on tube V104.	Check plate voltage of tube V101 and grid and cathode voltage of tube V104. Replace defective parts.
	Defective tube V104.	Replace tube V104.
	Open plate circuit of tube V104.	Check continuity through SERVICE and OPERATION switches and resistors R130 and R161. Replace defective parts or restore continuity of circuits.
No control when turning EXTENSION CURRENT knob.	Incorrect screen voltage on tube V104.	Check resistors R108 through R111. Replace defective parts.
No meter indication with METER knob on SEND LINE CURRENT and mark signal being transmitted.	Open resistor R147.	Check continuity of R147 and replace.
	Defective tube V105.	Replace tube V105.
	No plate voltage on tube V105.	Check continuity of leads to plate of tube V105.
No control when turning SENDING LINE CURRENT MARK knob.	Incorrect screen voltage on tube V105.	Check resistors R145, R146, and R147. Replace defective parts.
	Incorrect plate voltage on tube V106.	Check plate voltage of tube V106, and resistor R144.
No meter indication with METER knob on SEND LINE CURRENT and space signal being transmitted.	Plate resistor R144 open.	Replace.
	No grid voltage on tube V106.	Check plate voltage on V107. Replace if defective.
No control when turning SENDING LINE CURRENT SPACE knob.	Incorrect screen voltage on tube V106.	Replace resistors R142 and R143 if defective.
No meter indication with METER knob on REC LINE CURRENT.	Primary of transformer T101 open.	Check continuity and replace defective parts.

c. One-Way Operation, Transmitting. When using the trouble-shooting chart below, turn the SERVICE switch to ONE WAY, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch to ON.

Symptom	Probable trouble	Corrections
No meter indication with METER knob on SEND EXT CURRENT.	No positive grid voltage on tube V104.	Check plate voltage of tube V101 and replace defective parts.
	Defective tube V104.	Replace tube V104.
	Open plate circuit of tube V104.	Check continuity through SERVICE and OPERATION switches and resistors R130 and R161. Restore circuit continuity or replace defective parts.
No control when turning EXTENSION CURRENT knob.	Incorrect screen voltage on tube V104.	Check resistors R108 through R111 and replace defective parts.
No meter indication with METER knob on SEND LINE CURRENT and mark signal being transmitted.	Open resistor R147.	Check; replace if necessary.
	Defective tube V105.	Replace tube V105.
	No plate voltage on tube V105.	Check continuity of leads to plate of tube V105.
No control when turning SENDING LINE CURRENT MARK knob.	Incorrect screen voltage on tube V105.	Check resistors R145, R146, and R147. Replace defective parts.
	Incorrect plate voltage on tube V106.	Check resistor R144 and replace if defective.
No meter indication with METER knob on SEND LINE CURRENT and space signal being transmitted.	Plate resistor R144 open.	Check resistor R144 and plate voltage of tube V106. Replace defective parts.
	No grid voltage on tube V106.	Check plate voltage of tube V107 and replace tube V107 if defective.
No control when turning SENDING LINE CURRENT SPACE knob.	Incorrect screen voltage on tube V106.	Replace resistors R142 and R143 if defective.

d. One-Way Operation, Receiving. When using the trouble-shooting chart below, turn the SERVICE switch to ONE WAY, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch off (down).

Symptom	Probable trouble	Corrections
Unequal meter deflections, METER knob on BALANCE.	Feedback voltages unequal.	Check plate voltage of tube V103 and d-c voltage at junction of resistors R106 and R107.
	Faulty diode in tube V102.	Replace tube V102.
	Faulty capacitor C101.	Replace capacitor C101.
No meter indication with METER knob on SEND EXT CURRENT.	No positive grid voltage on tube V104.	Check plate voltage of tube V101 and grid and cathode voltage of tube V104. Replace defective parts.
	Defective tube V104.	Replace tube V104.
	Open plate circuit of tube V104.	Check continuity through SERVICE and OPERATION switches and resistors R130 and R161. Replace defective parts or restore continuity of circuit.
No control when turning EXTENSION CURRENT knob.	Incorrect screen voltage on tube V104.	Check resistors R108 through R111 and replace defective parts.

e. Power Supply Unit. When using the trouble-shooting chart below, turn the SERVICE switch to FULL DX, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch to ON.

Symptom	Probable trouble	Corrections
Unable to obtain —150 volts (—75 on meter) with maximum clockwise rotation of —150 V ADJ control.	Defective tubes..	Check tubes in the order listed: V115, V109, V112, V113, and V117 (V117 in B model only).
	Faulty capacitor..	Check capacitors C107, C109, and C110 for breakdown or abnormal leakage and replace faulty capacitor. Check proper connection to capacitor C107 to insure proper polarity.
	Thyrite unit unbalanced (in unlettered and A models only).	Replace resistor R187.
Poor voltage regulation, —150 volts.	Defective tube V117.	Replace tube V117.
Unable to obtain +300 volts (+75 on meter) with maximum clockwise rotation of the +300 V ADJ potentiometer.	Defective tubes...	Check tubes in the following order: V114, V108, and V111. Replace defective tube.
	Faulty capacitor..	Check capacitors C102, C103, C105, and C106 for breakdown and replace defective capacitor. Check to see that connections to capacitors C102 and C103 are properly polarized.
Unable to obtain —300 volts (—75 on meter).	Defective tube...	Check tubes in the following order: V116 and V110. Replace defective tube.
	Faulty capacitor C111.	Replace.

43. Rapid Servicing Checks

To assist maintenance personnel in rapid servicing of defective units, tube socket voltage and resistance diagrams (figs. 27 and 39), a supplementary voltage measurement chart (*b* below), terminal board diagrams (fig. 28), and wiring diagrams (figs. 34 through 38) of the control unit are included in this manual.

a. Tube Socket Voltage and Resistance Diagrams (fig. 27).

(1) When making voltage measurements, turn the AC SUPPLY switch to ON, turn the SERVICE switch to FULL DX, turn the OPERATION switch to NORMAL, and throw the TRANSMITTER switch to ON. All voltage measurements given in the chart are positive d-c voltages measured with respect to ground, unless otherwise noted. All d-c voltage measurements were made with a 20,000-ohm-per-volt meter. Voltages indicated by H are 6.3 volts a-c measured between the heater terminals. Voltages indicated by H' are 5 volts a-c measured between filament terminals. All a-c voltages were measured with a 1,000-ohm-per-volt a-c meter.

(2) All resistance measurements were made to ground with all external cables disconnected. The SERVICE switch is set at FULL DX, the OPERATION switch is set at NORMAL, the TRANSMITTER switch is ON, and the AC SUPPLY switch is turned OFF.

b. Supplementary Voltage Measurement Chart.

Point of measurement	Input	Voltage
Junction of R106–R107.	Mark	—21.5 volts with respect to —150 volts.
	Space	+21.5 volts with respect to —150 volts.
Junction of R133–R134.	Mark	—42 volts.
	Space	—130 volts.
Junction of R174–R175.		+165 volts.

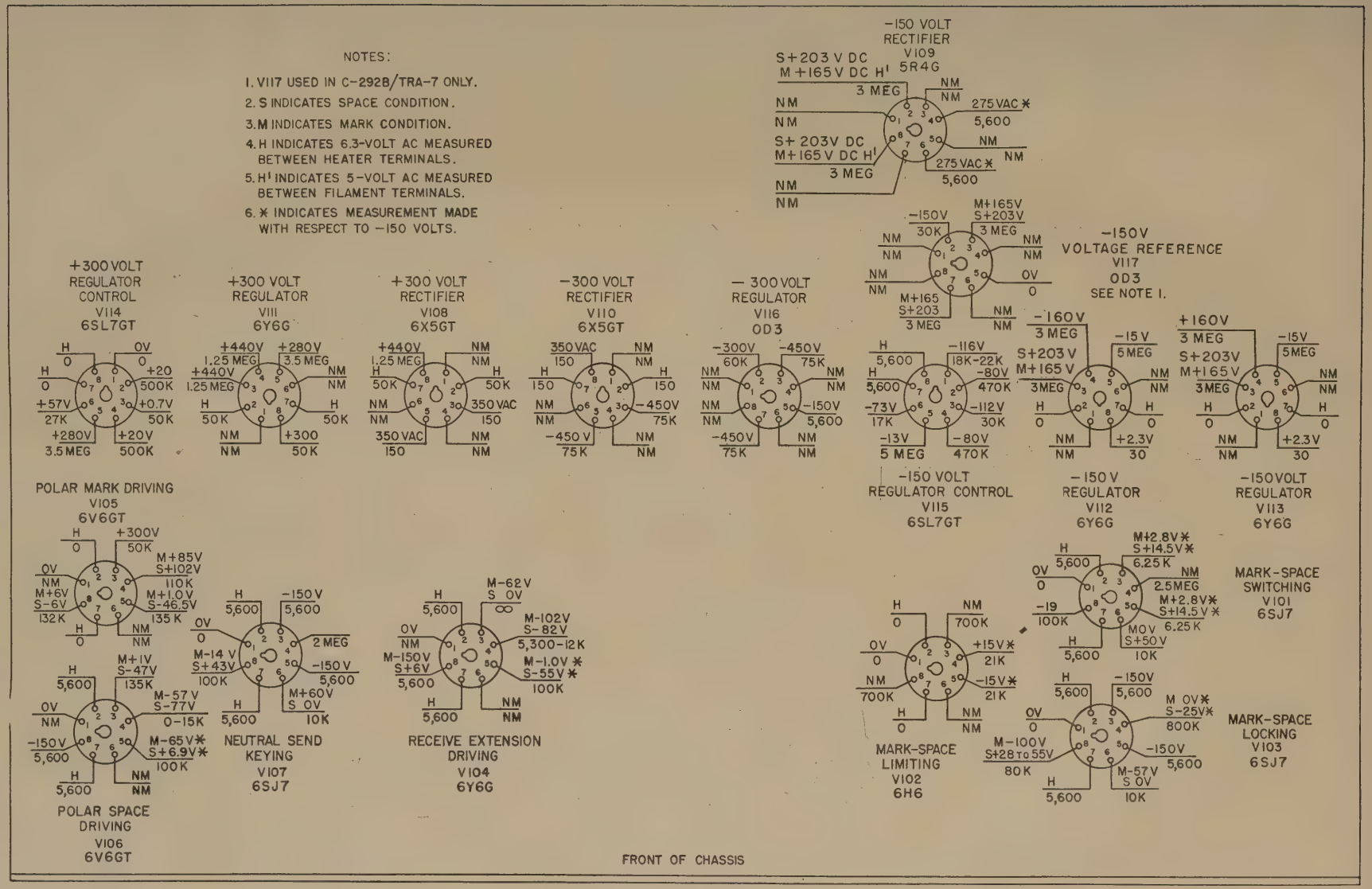


Figure 27. Control Unit C-292B/TRA-7 (procured on Orders No. 18723-P-49 and 15873-P-50), tube-socket voltage and resistance diagram.

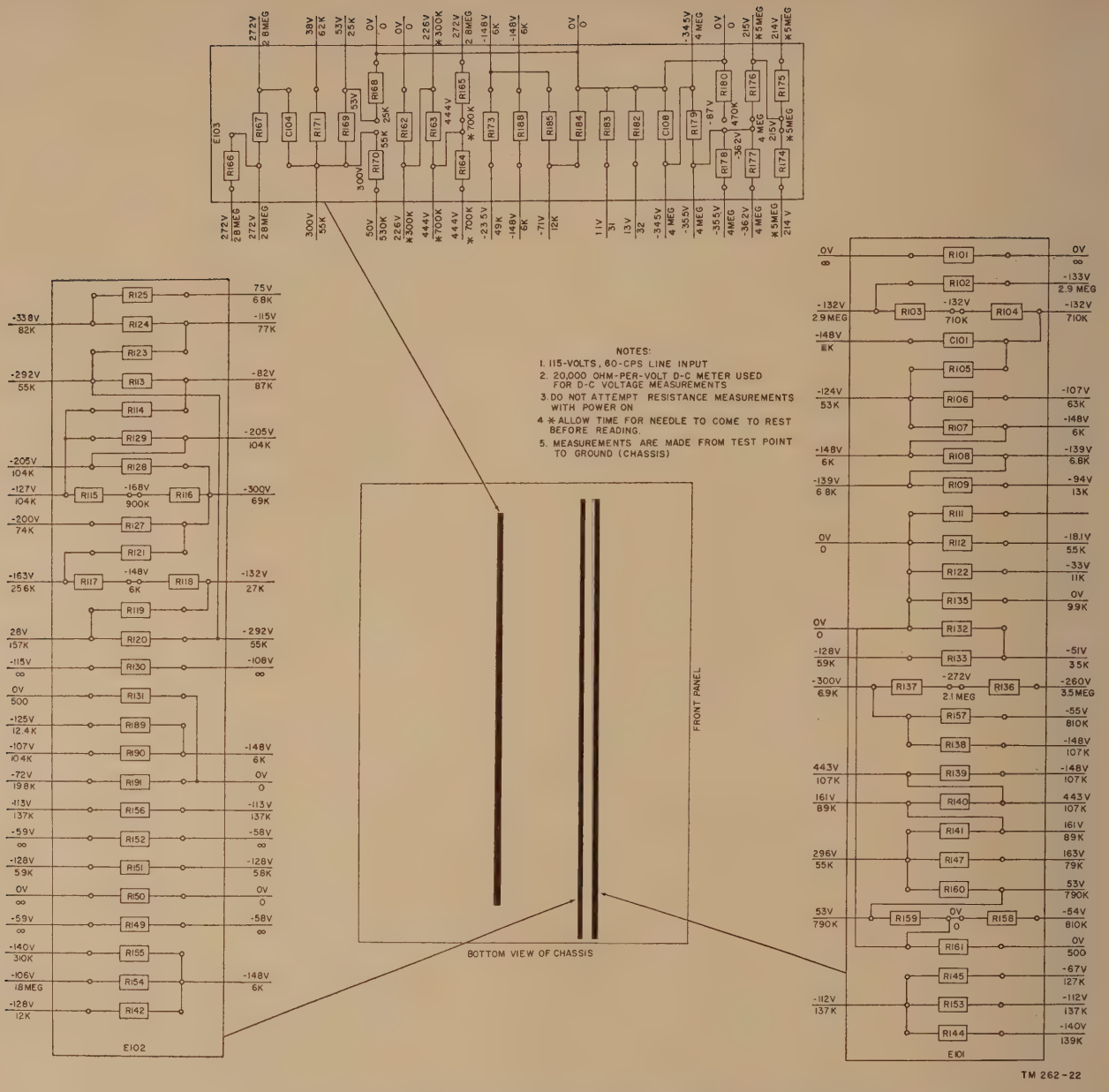


Figure 28. Control Unit C–292B/TRA–7 chassis terminal boards and identification of parts.

c. Control Unit C–292B/TRA–7 Tube Socket Voltage Measurements. The measurements in the chart below were made with an input of 115 volts a-c and a meter having a resistance of 20,000 ohms-per-volt d-c and 1,000 ohms-per-volt a-c. The measurements were made from the indicated point to ground. All voltages are positive unless ac or negative voltages are stated. The a-c cord was connected between a source of 115 volts and jack J107. Jack J103 of the control unit was connected to a source of TT signals and jack J102 was connected to a load equivalent to the shift tube circuit (360 ohms) in the exciter unit. The controls and switches were set as follows:

(1) AC SUPPLY switch to ON.
(2) SERVICE switch to FULL DX.
(3) OPERATION switch to NORMAL.
(4) TRANSMITTER switch to ON.
(5) EXTENSION CURRENT control set to full clockwise position.
(6) All other controls set in the normal operating position.

Tube	Signal	Receiving circuit pin number								Notes
		1	2	3	4	5	6	7	8	
V101	MARK	.....	—148	*—14.3	160.1	*3	.....	—148	*158	Depress RECEIVING TEST MARK button for MARK signal measurements and SPACE button for SPACE signal measurements.
	SPACE	.....	—148	*13.3	133	*13.8	—33	—148	*20.7	
V102	MARK	.....	.....	—14.3	—130.2	—162	.....	6.3AC	*—13.2	
	SPACE	.....	.....	13.3	—130.2	—162	.....	6.3AC	*13.2	
V103	MARK	.....	—148	—148	*—26.3	—148	*105	—148	*178	
	SPACE	.....	—148	—148	*—.2	—148	*147	—148	*7.5	
V104	MARK	.....	—148	—148	*8.5	*—.3	.....	—148	—148	
	SPACE	.....	—148	.....	*160.1	*—57	.....	—148	—148	
V105	MARK	.....	.....	300	52	1.0	.....	6.3AC	4.3	SEND LINE CURRENT MARK control set for a polar mark signal of 25 ma.
	SPACE	.....	.....	300	48	—40	.....	6.3AC	—4.3	
V106	MARK	.....	—148	1.0	—88	*—93	.....	—148	—148	SEND LINE CURRENT SPACE control set for a polar mark signal of —25 ma.
	SPACE	.....	—148	—40	—112	*7	.....	—148	—148	
V107	MARK	.....	—148	—148	*0	—148	60	—148	—140	
	SPACE	.....	—148	—148	*24	—148	.....	—148	43	

*Measurements made with respect to terminal 6 of T103.

d. Control Unit C–292B/TRA–7 Resistance Measurements at Tube Sockets. The resistance measurements in the chart below were made with all cords removed from the control unit. Unless otherwise specified, all resistances are made between the indicated point and ground. The controls and switches were set as follows:

(1) SERVICE switch to FULL DX.
(2) OPERATION switch to NORMAL.
(3) TRANSMITTER switch to ON.
(4) EXTENSION CURRENT control to full clockwise position.
(5) SEND LINE CURRENT MARK control to full clockwise position.
(6) SEND LINE CURRENT SPACE control to full clockwise position.
(7) All other controls in normal operating position.

Tube	Socket terminals							
	1	2	3	4	5	6	7	8
V101	.....	6K	6.8K	2.9 MEG	6.8K	11K	6K	104K
V102	.....	.....	710K	27K	25.6K	.....	.1	710K
V103	.....	6K	6K	900K	6K	11K	6K	82K
V104	.....	6K	.....	5K	104K	.....	6K	6K
V105	.....	.....	55K	78K	139K	.....	.1	137K
V106	.....	6K	139K	.....	107K	.....	6K	6K
V107	.....	6K	6K	2.1 MEG	6K	9.9K	6K	107K
V108	.....	55K	145	.....	145	.....	55K	700K
V109	.....	*2 MEG	.....	6K	.....	6K	.....	*2 MEG
V110	.....	140	77K	.....	77K	.....	140	140
V111	.....	55K	*700K	*700K	2.8 MEG	.....	55K	55K
V112	.....	.....	*5 MEG	*5 MEG	4 MEG	.....	.1	32
V113	.....	.....	*5 MEG	5 MEG	4 MEG	.....	.1	31
V114	.....	530K	55K	530K	2.8 MEG	25K	.....	.1
V115	19K	470K	10.4K	470K	4 MEG	12K	6K	6K
V116	.....	69K	77K	.....	6K	.....	77K	.....
V117	.....	10.4K	*5 MEG	.....	.....	.....	*5 MEG	.....

*Allow time for the needle to come to rest.

e. Control Unit C–292B/TRA–7 Voltage Measurements at Tube Sockets with no External Connections. Voltage measurements in the chart below were made with all cords, except the a-c input cord, disconnected from the control unit. Measurements were made

with an input of 115 volts a-c. The meter used has a resistance of 20,000 ohms-per-volt d-c and 1,000 ohms-per-volt a-c. Unless otherwise specified, all voltages are positive d-c voltages measured from the indicated point and ground. The controls and switches are set as follows:

(1) AC SUPPLY switch to ON.
(2) SERVICE switch to FULL DX.
(3) OPERATION switch to NORMAL.
(4) TRANSMITTER switch to ON.
(5) EXTENSION CURRENT control to full clockwise position.
(6) SEND LINE CURRENT MARK control to fully clockwise position.
(7) SEND LINE CURRENT SPACE control to full clockwise position.
(8) METER switch to SEND LINE CURRENT.
(9) All other controls in normal operation position.

Tube	Socket terminals							
	1	2	3	4	5	6	7	8
V101	.....	—148	—139	—133	—139	—33	—148	—127
V102	.....	.....	—132	—132	—163	.....	6.3AC	—132
V103	.....	—148	—148	—168	—148	.....	—148	33.8
V104	.....	—148	—59	—86	—205	.....	—148	—148
V105	.....	.....	300	—57	—140	.....	6.3AC	—112
V106	.....	—148	—140	—120	—148	.....	—148	—148
V107	.....	—148	—148	—272	—148	.....	—148	44.3
V108	.....	300	360AC	.....	360AC	.....	300	444
V109	.....	218	.....	—150	.....	—150	.....	218
V110	.....	360AC	—452	.....	—452	.....	360AC	360AC
V111	.....	300	444	444	272	.....	300	300
V112	.....	.....	215	214	—35.5	.....	6.3AC	1.3
V113	.....	.....	215	214	—36.2	.....	6.3AC	1.1
V114	.....	50	122	50	272	53	6.3AC	.....
V115	—107	—87	—107	—87	—35.5	—71	—148	—148
V116	.....	—300	—452	.....	—148	.....	—452	.....
V117	.....	—107	218	.....	.....	.....	215	.....

Section II. REPAIRS

44. Replacement of Parts

a. Whenever the control unit is serviced, carefully observe the following precautions:

(1) Be careful when the bottom cover is removed; dangerous voltages are exposed.

(2) Careless replacement of parts often makes new faults inevitable. Observe the following points:

(*a*) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads to it.

(*b*) Be careful not to damage other leads by pulling or pushing them out of the way.

(*c*) Do not allow drops of solder to fall into the set; they may cause short circuits.

(*d*) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly-soldered joint is one of the most difficult faults to find.

(*e*) When a part is replaced, it must be placed exactly as the original one was. A part which has the same electrical value but different physical size may cause trouble in high-frequency circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring.

b. The following repair instructions pertain to specific parts:

(1) To remove power transformer T102 it is necessary to remove capacitor C106. To remove power transformer T103 it is necessary to remove capacitor C110.

(2) When replacing thermistor R187, take care in unsoldering leads from the defective part and soldering them to the new thermistor. Because of the critical balance of the circuit, the leads must be kept short.

(3) The SERVICE, METER, and OPERATION switches of the control unit are multisection switches which require careful handling in replacement. When these switches are replaced, the wires connected to the original switch should be marked with tags or other devices to avoid errors in reconnecting the new switch.

(4) When replacing capacitors C102 and C107, be sure to reinstall the capacitor shields. These shields are finished with a special insulating paint which isolates capacitors C102 and C107 from ground.

45. Wiring Diagrams

The wiring diagram for Control Unit C–292/TRA–7 is shown in figure 37. Wiring diagrams for Control Unit C–292A/TRA–7 are shown in figures 36 through 38.

a. In figure 35 each piece of apparatus has the same designation as that stamped on the equipment, and the wiring terminals on each piece of apparatus are shown in their proper relative locations as viewed from the wiring side. Figure 35 uses the airline system of showing connections. With this system each piece of apparatus is arbitrarily numbered and feed lines representing the individual wires are carried a short distance and terminated at a common line running at right angles to the feed lines. These feed lines are marked with the color of the wire and have a number near the base line. This number is the same as the number of the piece of apparatus to which the other end of the wire connects. It is not necessary to trace a connection through the common or base line, and no provision is made for doing so. By observing the color and the identification number, it is possible to move directly to the other end of the wire.

b. In figures 36 and 37, a modified airline system is used to show connections. Each jumper wire not included as a part of a component subassembly is designated by a symbol and is represented by a line running from terminal to terminal. The description and the method of dressing each wire is indicated in a table on the diagram. In the diagrams, a cable harness assembly is represented by parallel lines with cross-hatching. Points where a wire or wires emerge from the cable harness assembly are designated STATIONS and are numbered in sequence along the cable. At the point where a wire emerges from a STATION, its color code is indicated, and there is a number which indicates the distant STATION from which the other end of the wire ultimately emerges. By observing the color code and station reference designations at one end of a wire it is possible to locate the other end quickly. This is the case for all wires which are a part of a cable harness assembly.

46. Alinement Procedures

No test equipment or conventional alinement procedures are necessary, because of the nature of the electronic circuits in Control Unit C–292(*)/TRA–7. The only adjustments required are those pertaining to the —150V ADJ and +300V ADJ controls determining the output voltage of the +150-volt and +300-volt regulated supplies, respectively. Adjustment of these controls is described in paragraph 41.

Section III. FINAL TESTING

47. General

This section is intended as a guide to be used in determining the quality of a repaired Control Unit C–292(*)/TRA–7. The minimum test requirements may be performed by maintenance personnel with adequate test equip-

ment and the necessary skills. Repaired equipment meeting these specifications will furnish uniformly satisfactory operation. The construction of the test set-up and the artificial line described in this section (figs. 29 and 30) may not be warranted if only one (or a few) control unit is to be repaired.

48. Test Equipment Required

The following test equipment is necessary to perform the tests in this section:

Repeater Control Test Cabinet, WECo #SID–107079, or equal.
Distributor, WECo #100A, or equal.
Teletypewriter distributor, WECo #14F, or equal.
Distortion measuring set, WECo #164–A, or equal.
Multimeter TS–352/U, or equal.
Electronic Multimeter ME–6A/U, or equal.
Test cords and cables.
Control unit test set-up and 10 miles of artificial line (figs. 29 and 30).

49. Preliminary Tests

Preliminary continuity and resistance checks are made before the control unit is supplied with power.

a. Continuity. Use Multimeter TS–352/U for the continuity tests on the control unit. Check the continuity of the circuit between C and D of J101 with the TRANSMITTER switch operated to the ON position and the SERVICE switch to the ONE WAY position. The continuity should be broken when either the TRANSMITTER switch is restored to its unoperated position or the SERVICE switch is operated to HALF DX or FULL DX. Continuity should be had in the following measurements:

From	*To*
Shield on 5 of V104	Ground
Shield on R128	Ground
Shield on R129	Ground
Shield on 8 of V104	Ground
Shield on 5 of V107	Ground
Shield on 4 of V107	Ground
Shield on R136	Ground
Shield on R137	Ground
Shield on R130	Ground
A of J101	1 of T101
C of J101	12L of S102
C of J102	12L of S104B
A of J102	Ground

b. Resistance. Use Multimeter TS–352/U for the following resistance tests:

From	*To*	*Ohms*
4 of T101	9L of S102	2.2 meg ±220K
9L of S102	4 of V101	47K ±4.7K
6 of V101	Ground	10K ±1K
6 of V103	Ground	10K ±1K
5 of V101	6 of T103	1.1K ±55 ohms

50. Preparation for Operating Tests

Connect the repeater test cabinet as explained in subparagraph *a* below:

a. Connections.

(1) Reduce the *variac* output to zero as indicated by the a-c line voltmeter; then make the following connections between the test panel (fig. 29) and the unit under test:

From test set	*To Control unit*
J101	J101
J102	J102
J103	J103
VARIAC OUT	J107

(2) Insert the proper tubes in their respective sockets.

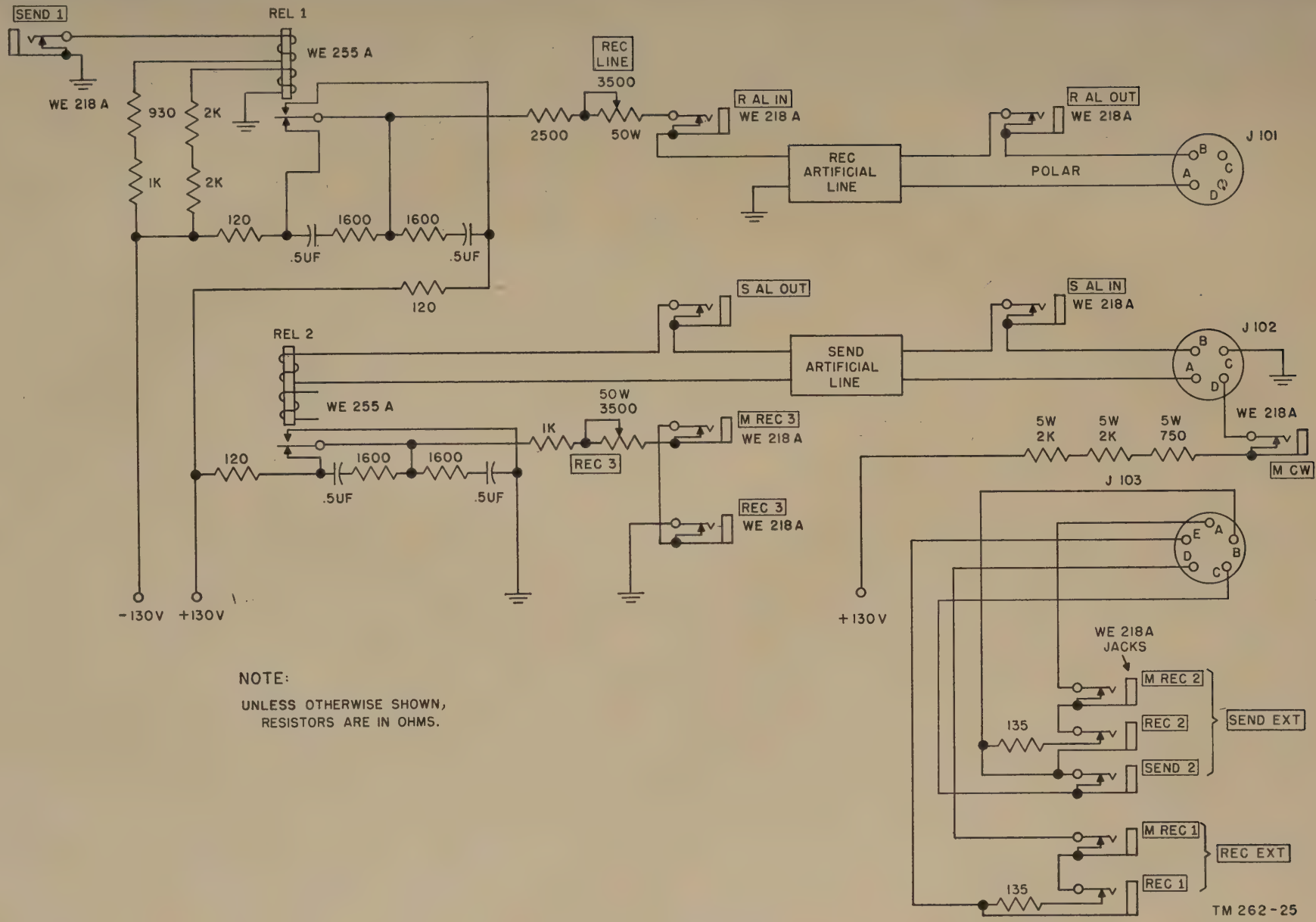
(3) Operate the EXTENSION CURRENT, the SENDING LINE CURRENT MARK, and the SENDING LINE CURRENT SPACE controls to their extreme counterclockwise positions.

(4) Connect the regulated 115-volt line to the lower variac panel, and maintain the input voltage to the test cabinet and the distortion measuring set at 120 volts.

(5) Connect the control unit to 120-volt, 50- to 60-cycle a-c through the variac.

b. Indicator Lamp Check.

(1) Operate the switch on the variac test panel to ON. Operate the control unit AC SUPPLY switch to ON and check that the AC SUPPLY lamp lights when the variac is adjusted to give 115 volts on the power panel meter.



NOTE:

UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS.

Figure 29. Final test set-up.

(2) Check that the transmitter indicator lamp lights when the TRANSMITTER switch is operated to ON.

c. Checking Positive and Negative 130-Volt Supplies. Operate the METER switch on the test set to POS P.S.; the meter should read 65 ±1, with the a-c input voltage set to 120 volts.

51. Power Supply Tests

a. Preliminary.

(1) Maintain the variac input at 115, ±1 volts.

(2) Operate the SERVICE switch to FULL DX, the OPERATION switch to NORMAL, the AC SUPPLY switch to ON, and the TRANSMITTER switch to ON. These switches should remain in these positions unless otherwise specified during the test.

(3) Set the SEND and REC artificial lines in the test circuit to zero mile.

b. Power Supply Checks.

(1) *Heater voltages.* The voltages at terminals 2 and 7 of vacuum tubes V101, V102, V106, and V109, and V110 terminals 2 and 8 shall be as follows:

V101	6.3 ±.3 volts a-c.
V102	6.2 ±.3 volts a-c.
V106	6.3 ±.3 volts a-c.
V109	5.0 ±.3 volts a-c.
V110	6.4 ±.3 volts a-c.

(2) *—150 Volt Supply.* Momentarily depress the RECEIVING TEST MARK key. Check that the voltage of terminal 6 of transformer T103 with respect to chassis ground may be varied over the range —140 to —160 volts by means of the —150V ADJ control. Note that the voltage *increases* with *clockwise* rotation. Adjust the —150V ADJ control to give a reading of —150 volts.

(3) *+300 Volt Supply.* Check that the voltage of terminal 8 of tube V111 with respect to chassis ground may be varied over the range +270 to +300 volts by means of the +300V ADJ potentiometer. Note that the voltage increases with clockwise rotation. Adjust the +300V ADJ potentiometer to give a reading of +300 volts.

(4) *—300 Volt Supply.* The voltage at terminal 2 of tube V116 with respect to chassis ground shall be between —290 and —315 volts.

(5) *METER readings.* With the control unit standing on its base, check that with the METER switch in the —150 VOLT SUPPLY and the +300 VOLT SUPPLY positions, the meter M101 reading is —75, ±5 and +75, ±5 respectively. With the METER switch in the —300 VOLT SUPPLY position, the meter reading shall be —75, ±8.

52. Voltage and Current Checks, Full DX

a. With the REC artificial line set to zero mile KEY SND 1S set at NORMAL, adjust the REC LINE rheostat in the test circuit to give 25 ma as measured at the R AL IN jack (input to REC artificial line). Operate the METER switch in the control unit to REC LINE CURRENT. The meter M101 reading shall be +67 ±6. Insert an open circuit plug into the SEND–1 jack. The meter reading shall then be —67 ±6. Operate KEY SND 1S; the meter at R AL IN should read —25 ±1. The meter on the control unit should read —67 ±6. Release KEY SND 1S.

b. Operate the METER switch to BALANCE. Adjust the BALANCE ADJ. potentiometer so that when the RECEIVING TEST MARK and SPACE keys are alternately depressed, meter M101 will read equally to the right and left, respectively. The indications should be approximately 75 to the right when the MARK key is depressed and 75 to the left when the SPACE key is depressed.

c. Momentarily depress the RECEIVING TEST MARK key. The voltage *across* R108 shall be 2.6, ±.5 volt. Momentarily depress the RECEIVING TEST SPACE key. The voltage *across* R108 shall be 14, ±2 volts.

d. Momentarily depress the RECEIVING TEST MARK key. The voltage at terminal 8 of tube V101 shall be +19 ±10 volts with respect to ground. Depress the SPACE key. The voltage at terminal 8 of V101 shall be —130, ±15 volts with respect to ground.

e. Measure the voltage at junction of R115 and R116 with respect to terminal 6 of T103. Using the 50-volt scale, the indicated voltage shall be —25, +15 volts.

f. The voltage at terminal 8 of tube V103 shall be between +28 and +55 volts with respect to ground. Momentarily depress the RECEIVING TEST MARK key. The voltage shall then be —140 ±15 volts with respect to ground.

g. Momentarily depress the RECEIVING TEST SPACE button. The voltage at terminal 5 with respect to terminal 8 of V104 shall be —55, ±15 volts.

h. The voltage at the junction of R106 and R107 with respect to terminal 6 of T103 shall be +22, ±3 volts. Momentarily depress the RECEIVING TEST MARK KEY. The voltage shall remain within 2 volts of the previous value but shall be opposite in polarity.

i. The voltage at the junction of R117 and R121 shall be —15, ±2 volts with respect to terminal 6 of T103.

j. The voltage at the junction of R118 and R119 shall be +15, ±2 volts with respect to terminal 6 of T103.

k. The voltage at the junction of R133 and R134 shall be —42, ±5 volts with respect to ground. Insert an open circuit plug into the SEND 2 jack of the test circuit (or use SND 2S KEY). The voltage shall be —130, ±5 volts.

l. With an open circuit plug in the SEND 2 jack, the voltage, measured on the 250-volt scale of the voltmeter, at the junction of R136 and R137 with respect to terminal 5 of tube V107 shall be —36, ±10 volts.

m. The voltage at terminal 8 of V107 shall be +43, ±15 volts with respect to ground. Remove the plug from the SEND 2 jack. The voltage shall be —140, ±20 volts.

n. The voltage at the junction of R138 and R139 shall be —65, ±15 volts with respect to terminal 8 of V106.

o. Set the control unit on its base. Operate the METER switch to SEND LINE CURRENT. With the SENDING LINE CURRENT MARK and SPACE potentiometers in their extreme counterclockwise positions, M101 meter reading shall lie between +20 and +50. Note that the meter reading increases smoothly to an end of scale reading as the SENDING LINE CURRENT MARK knob is turned in a clockwise direction. Adjust this potentiometer for a meter indication of +75. The current measured on a zero-center milliameter at the AL IN jack of the test circuit shall be +28, ±2 ma.

p. Insert an open circuit plug into the SEND 2 jack of the test circuit. Meter M101 reading shall lie between —5 and —30. Note that the meter reading increases smoothly to an end of scale reading as the SENDING LINE CURRENT SPACE potentiometer is turned in a clockwise direction. Adjust this potentiometer for a meter reading of —75. The current measured at the AL IN jack of the test circuit shall be —28, ±2 ma. Remove the open circuit plug from the SEND 2 jack.

q. Operate the METER switch to SEND EXT-CURRENT. Meter M101 shall read +75, ±7. The current measured in the M REC 2 jack of the test circuit shall be 64, ±4 ma.

r. Operate the METER switch to REC EXT-CURRENT. Momentarily depress the RECEIVING TEST MARK key. With the EXTENSION CURRENT potentiometer in its extreme counterclockwise position, M101 meter reading shall be +55, ±10. Note that the meter reading increases smoothly to an end of scale reading as the EXTENSION CURRENT potentiometer is turned clockwise. Adjust the EXTENSION CURRENT potentiometer for a meter indication of +75. The current reading in the M REC 1 jack of the test circuit shall be 62, ±6 ma. Momentarily depress the RECEIVING TEST SPACE key. The reading on both meters shall be less than 1.

53. Current Checks, Half DX

a. Operate the SERVICE switch to HALF DX. Momentarily depress the RECEIVING TEST MARK key. M101 meter reading shall be zero on the REC EXT-CURRENT position.

b. Operate the METER switch to SEND EXT-CURRENT. The M101 meter reading shall be +75, ±3.

54. Checks, One Way

a. Operate the SERVICE switch to ONE WAY. The 1 WAY indicator lamp should light and DX lamp should be extinguished.

b. M101 meter should read +75, ±3 for the SEND EXT-CURRENT. Operate KEY SND 1S; the meter reading should not change. Restore KEY SND 1S to NORMAL.

c. Set the TRANSMITTER switch in its off position. Lamps ON and 1 WAY should be extinguished, but DX and OFF should be lighted. The SND EXT-CURRENT reading should be +75, ±3. Operate the KEY SND 1S; the meter reading should be less than 1. Restore KEY SND 1S to NORMAL.

55. Checks, Emergency Frequency Shift

a. Operate the SERVICE switch to FULL DX and the TRANSMITTER switch to ON. The current measured at the M CW jack shall be between 20 and 25 ma. Turn the OPERATION switch to EMERG FS. The current at the M CW jack shall remain unchanged. Turn the TRANSMITTER switch to its unoperated position. The current at the M CW jack shall be zero. Turn the TRANSMITTER switch to ON.

b. With the OPERATION switch set at EMERG FS, make the following tests:

(1) Momentarily depress the RECEIVING TEST MARK key. With the SERVICE switch at FULL DX and the METER switch at SEND EXT-CURRENT, M101 meter shall indicate zero.

(2) Turn the METER switch to REC EXT-CURRENT. M101 meter shall indicate +66, ±7. The current at M REC 1 jack shall be 57, ±6 ma.

(3) Turn the METER switch to SEND LINE CURRENT. M101 meter shall indicate +75, ±2.

(4) Momentarily depress the RECEIVING TEST SPACE key. M101 meter shall indicate —75, ±2.

(5) Turn the SERVICE switch to HALF DX. There shall be no change in M101 meter indication.

(6) Momentarily depress the RECEIVING TEST MARK key. M101 meter shall indicate +75, ±2.

(7) Turn meter knob to SEND EXT-CURRENT. M101 meter indication shall be within one-half division of the reading in (2) above.

(8) Insert an open circuit plug in SEND 2 jack. There shall be no change in M101 meter indication. Remove the open circuit plug from the SEND 2 jack.

56. Emergency C-W Checks

Turn the OPERATION switch to EMERG CW and make the following tests:

a. Place the SERVICE switch in the HALF DX position and momentarily depress the RECEIVING TEST MARK key. The current at the M REC 2 jack shall be 48, ±5 ma.

b. Insert an open circuit plug into the SEND 2 jack. There shall be no change in the current measured at the M REC 2 jack.

c. The current measured at the M CW jack shall be 35, ±5 ma.

d. Insert an open circuit plug into the SEND —1 jack. The current at the M CW jack shall be zero.

e. Turn the SERVICE switch to FULL DX. The M CW current shall be zero.

f. Remove the open circuit plug from the SEND 1 jack. The M CW current shall be 35, ±5 ma.

g. The current at the M REC 1 jack shall be within 2 ma of the reading in *a* above.

h. The current at the M REC 2 jack shall be 64, ±4 ma.

57. Power Supply Circuit Ripple Voltage

a. Preparatory.

(1) Turn the SERVICE switch to FULL DX, the OPERATION switch to NORMAL, and the TRANSMITTER switch to ON. Connect the a-c input of the control unit to the unregulated 115-volt source. Turn the AC SUPPLY switch to ON.

(2) Insert open circuit plugs into the SEND 1 and SEND 2 jacks. Adjust the a-c input voltage to the control unit to 127 volts by means of the variac.

b. —150 Volt Supply. Connect Electronic Multimeter ME–6A/U, or its equal, between terminal 6 of T103 and ground. The voltage measured shall not exceed 100 mv (millivolts).

c. +300 Volt Supply. Connect the VTVM (vacuum-tube voltmeter) between terminal 8

of V111 and ground. The voltage shall not exceed 100 mv.

d. —300 Volt Supply. Connect the VTVM between terminal 2 of V116 and ground. The voltage shall not exceed 600 mv. Check that the d-c voltage at terminal 2 of V116 with respect to ground lies between —290 and —315 volts.

e. —150 Volt Supply. Remove the open circuit plugs from the SEND 1 and SEND 2 jacks. Adjust the a-c input voltage to the control unit to 103 volts. Repeat test of *b*, above.

f. +300 Volt Supply. Repeat test of *c*, above.

g. —300 Volt Supply. Repeat test of *d*, above. Replace control unit a-c plug in regulated 115-volt line.

58. Transmission Tests

Adjust the a-c input voltage to 115 volts. It is assumed that the final tests and adjustments specified in the preceding paragraphs have been made. Adjust the REC 3 rheostat for a meter indication of +60 ma in the REC 3 jack. In each of the following transmission tests, the maximum distortion observed during a ½-minute period shall be recorded as the distortion.

a. Full Duplex Tests.

(1) With the SERVICE switch in the FULL DX position, connect a source of miscellaneous teletypewriter signals to the SEND 2 jack of the test circuit. Connect a source of reversals (approximately 20 dots per second) to the SEND 1 jack. Connect the transmission measuring set to the REC 2 jack. The distortion measured at the REC 2 jack shall not exceed 5 percent.

(2) Connect the transmission measuring set to the REC 3 jack. The distortion shall not exceed 8 percent.

(3) Remove the signals from the SEND 1 and SEND 2 jacks. Set the SEND artificial cable line at 10 miles. Adjust the SENDING LINE CURRENT MARK potentiometer to give a current of +25 ma measured at the S AL IN jack. Insert an open circuit plug into the SEND 2 jack. Adjust the SENDING LINE CURRENT SPACE potentiometer to give —25 ma at the S AL IN jack. Remove the open circuit plug.

(4) Connect miscellaneous teletypewriter signals to the SEND 2 jack and reversals to the SEND 1 jack. The distortion at the REC 3 jack shall not exceed 8 percent.

(5) Repeat (4) above with an a-c line voltage of 127 volts.

(6) Repeat (4) above with an a-c line voltage of 103 volts.

(7) Readjust the a-c line voltage to 115 volts. Connect miscellaneous teletypewriter signals to the SEND 1 jack of the test circuit. Connect the reversals to the SEND 2 jack. Connect the transmission measuring set to the REC 1 jack. The distortion shall not exceed 8 percent.

(8) Remove miscellaneous signals from the SEND 1 jack. Set the REC artificial line at 10 miles, and adjust the REC LINE rheostat for a meter reading of +25 ma at the R AL IN jack. Reconnect the miscellaneous signals to the SEND 1 jack.

(9) Repeat (7) above. The distortion at the REC 1 jack shall not exceed 8 percent.

(10) Repeat (9) above with the a-c line voltage raised to 127 volts.

(11) Repeat (9) above with the a-c line voltage reduced to 103 volts.

(12) Readjust the a-c line voltage to 115 volts. Turn the OPERATION switch to EMERG FS. Connect the transmission measuring set to the REC 3 jack. Remove the reversals from the SEND 2 jack. With miscellaneous TT signals connected to the SEND 1 jack, the distortion at the REC 3 jack shall not exceed 8 percent.

b. Half Duplex Tests.

(1) Turn the SERVICE switch to HALF DX and the OPERATION switch to NORMAL. Connect the source of miscellaneous TT signals to the SEND 2 jack. Connect the transmission measuring set to the REC 3 jack. The measured distortion shall not exceed 8 percent.

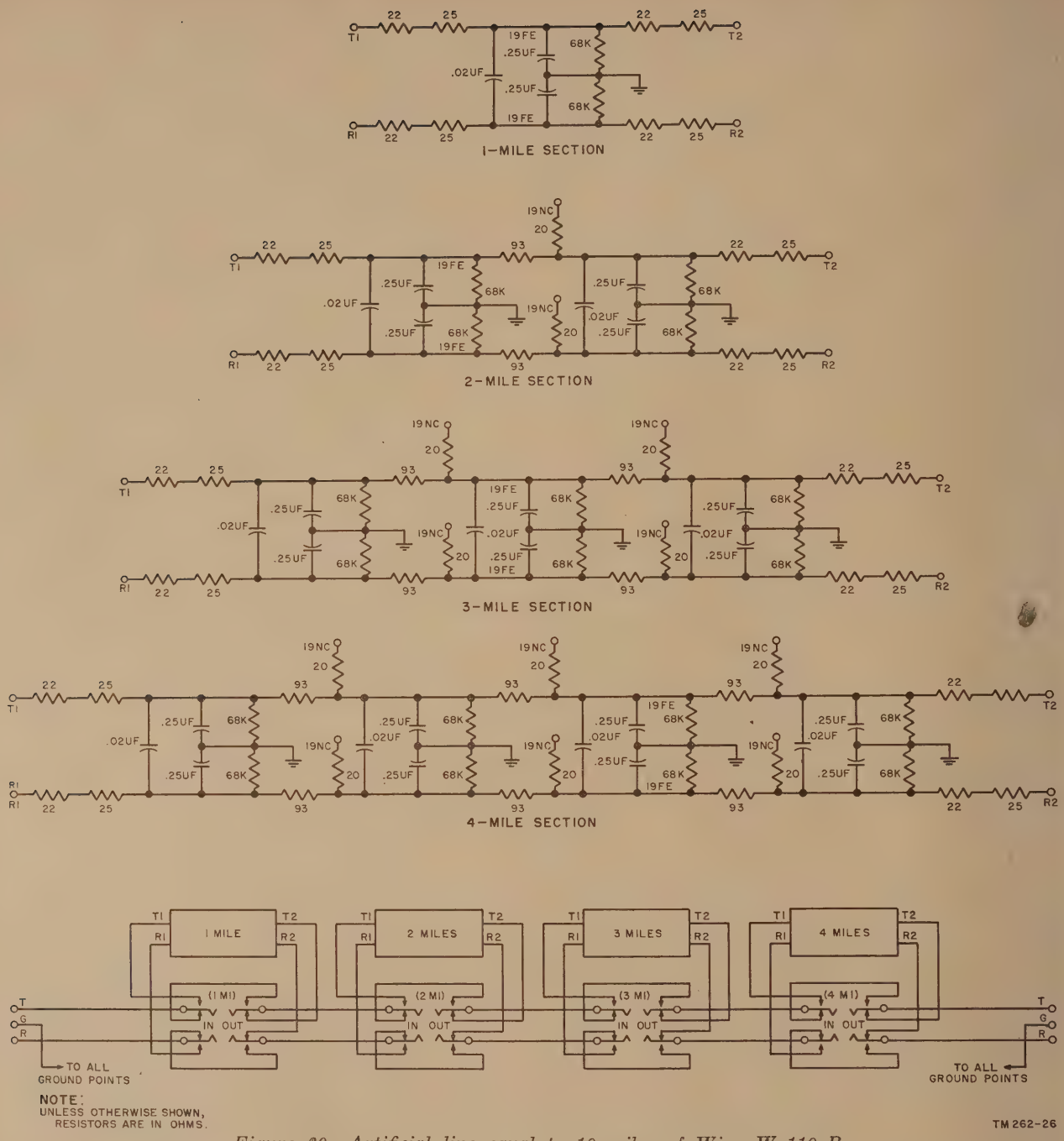


Figure 30. Artificial line equal to 10 miles of Wire W–110–B.

(2) Connect the transmission measuring set to the REC 2 jack. The distortion shall not exceed 5 percent.

(3) Connect the TT signals to the SEND 1 jack. The distortion at the REC 2 jack shall not exceed 8 percent.

c. One Way Reversible Tests.

(1) Operate the SERVICE switch to ONE WAY and the TRANSMITTER switch to the off position. With TT signals connected to the SEND 1 jack, the distortion at the REC 2 jack shall not exceed 8 percent.

(2) Operate the TRANSMITTER switch to ON. Connect the TT signals to the SEND 2 jack. Connect the source of reversals to the SEND 1 jack. Connect the transmission measuring set to the REC 3 jack. The distortion shall not exceed 8 percent.

CHAPTER 5

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

59. General

The exact procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored.

60. Repacking for Shipment or Limited Storage

Whenever practicable, place a dehydrating agent such as silica gel inside the chests. Protect the chests with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected chests in a padded wooden case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

61. General

The demolition procedures outlined in paragraph 62 will be used to prevent the enemy from using or salvaging the equipment. Demolition of the equipment will be accomplished only upon order of the commander.

62. Methods of Destruction

a. Smash. Smash the meter, controls, tubes, switches, capacitors, transformers, and case, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut chassis wiring using axes, handaxes, or machetes.

c. Burn. Burn resistors, capacitors, wiring, and technical manuals, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

g. Destroy. Destroy everything.

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR 310–20–3 and SR 310–20–4. Check Department of the Army Supply Catalog SIG 1 for Signal Corps supply catalogs.

1. Army Regulations

AR 380–5	Safeguarding Military Information.
AR 750–5	Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation).

2. Supply Publications

SIG 1	Introduction and Index.
SIG 3	List of Items for Troop Issue.
SIG 5	Stock List of All Items.
SIG 6	Sets of Equipment.
SIG 7 & 8	Organizational Maintenance Allowances and Field and Depot Maintenance Stockage Guide.
SB 11–6	Dry Battery Supply Data.
SB 11–47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11–76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Technical Manuals on Test Equipment

NAVSHIPS 91,254	Instruction Book for Tube Tester TV–3/U.
NAVSHIPS 91,269	Electronic Multimeter ME–6A/U.
NAVSHIPS 91,272	Oscilloscope OS–8/U.
TM 11–300	Frequency Meter Sets SCR–211–(*).
TM 11–307	Signal Generators I–72–G, H, J, K, and L.
TM 11–472	Repair and Calibration of Electrical Measuring Instruments.
TM 11–2045	Decibel Meter TS–399/U, 13A (SPL), Transmission Measuring Set Per D–165655 (Moisture-Resistant).
TM 11–2096	Signal Generator SG–15/PCM.
TM 11–2627	Tube Testers I–177 and I–177–A.
TM 11–2673	Multimeter TS–389/U (Hickok Models 202 and 202–NX).
TM 11–2684A	Audio Oscillator TS–382A/U.
TM 11–4052	Signal Generators I–72–A, –B, –C, –D, –E, –F, –G, –H, –J, and –K. Repair Instructions.
TM 11–5511	Electronic Multimeter TS–505/U.
TM 11–5527	Multimeter TS–352/U.

4. Painting, Preserving, and Lubrication

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69	Lubrication of Ground Signal Equipment.
TM 9–2851	Painting Instructions for Field Use.

5. Camouflage

FM 5–20	Camouflage, Basic Principles.
TM 5–267	Camouflage.

6. Decontamination

TM 3–220	Decontamination.

7. Demolition

FM 5–25	Explosives and Demolitions.

8. Other Publications

FM 24–18	Field Radio Techniques.
SR 310–20–3	Index of Training Publications (Field Manuals, Training Circulars, Firing Tables and Charts, Army Training Programs, Mobilization Training Programs, Army Training Tests, Graphic Training Aids, Joint Army-Navy-Air Force Publications, Combined Communications Board Publications, and Army Communications Publications).
SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 700–45–5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD–247).
SR 745–45–5 NAV DEPT SERIAL 85P00 AFR 71–4	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD–66 (Army), SandA–70–6 (Navy), and AF–MC–U2 (Air Force).
TB SIG 25	Preventive Maintenance of Power Cords.
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.

TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TM 11–264	Radio Set AN/GRC–26.
TM 11–333	Telephones EE–8, EE–8–A, and EE–8–B.
TM 11–359	Line Units BE–77, BE–77–A, BE–77–B, & BE–77–C.
TM 11–415	Dry Batteries.
TM 11–430	Batteries for Signal Communication. Except those pertaining to Aircraft.
TM 11–453	Shop Work.
TM 11–455	Radio Fundamentals.
TM 11–661	Electrical Fundamentals (Direct Current).
TM 11–466	Radar Electronic Fundamentals.
TM 11–483	Suppression of Radio Noises.
TM 11–624	Radio Sets AN/MRC–2 and –2A.
TM 11–680	Teletypewriter Circuits and Equipment (Fundamentals).
TM 11–681	Electrical Fundamentals (Alternating Current).
TM 11–2222	Receiving Transmitter Distributors TT–12/FGQ–1, TT–13/FGQ–1 and Transmitter Distributors TT–21/FG, TT–25/FG, TT–26/FG, TT–52/FG. (Including other Teletype Model 14 Distributors.)
TM 11–2223	Typing and Nontyping Reperforators Teletype Model 14.
TM 11–4000	Trouble Shooting and Repair of Radio Equipment.
TM 11–5025	Oscillator 0–73/URT.

9. Abbreviations

a-c	alternating-current
a-f	audio-frequency
c-w	continuous-wave
db	decibels
d-c	direct-current
DPDT	double-pole, double-throw
DX	duplex
f-m	frequency-modulated
FS	frequency shift
hex	hexagonal
h-f	high-frequency
h-v	high-voltage
i-f	intermediate-frequency
in.	inch
ins	insulator, insulated
K	kilo or 1,000
kc	kilocycle
lb	pound
l-f	low-frequency
lg	long
ma	milliampere
max	maximum
mc	megacycle
meg	megohm
mh	millihenry
min	minimum
ms	millisecond
mtg	mounting
mtg/c	mounting center
mv	millivolt
mw	milliwatt
oper	operation
pl	plated
psi	pounds per square inch
r-f	radio-frequency
RMS	root mean square
RTT	radioteletype
scdr	screwdriver
SD	Solvent, dry-cleaning
SLC	straight line capacity
SOP	standing operating procedure
SPST	single-pole, single-throw

TD .....transmitter-distributor
term. .....terminal
thk .....thick
TT .....teletypewriter
ua .....microampere
UF or uf .....microfarad
uuf .....micromicrofarad
uv .....microvolt
v or V .....volt
VTVM .....vacuum-tube voltmeter
w .....watt
wd .....wide
wpm .....words per minute

10. Glossary

For explanation of the terms used in this manual, refer to TM 11–455, and TM 11–499, and TM 11–680 and the following list:

Ambient humidity—The humidity of the surrounding air; the room humidity.

Ambient temperature—The temperature of the air surrounding the test set-up.

Anodized—An electrical treatment given to aluminum and other metals for the purpose of increasing the corrosion and oxidation resistance of the metal. The treatment is similar to electroplating but there is no deposition of other metal.

Balanced mixer—Also called a balanced modulator. An amplifier in which the tube control grids are connected for push-pull operation and the cathode circuit has parallel input. The plates are operated in push-pull, and the signal applied to the grids is balanced out and does not appear in the output.

Bias distortion—This term is used in relation to the distortion of the square-wave teletypewriter keying signal. If the positive and negative d-c pulses are not of equal length and of square shape, they are said to have bias distortion. See TM 11–680.

Carrier shift keying—An elementary form of frequency modulation in which a c-w (continuous-wave) signal is shifted in frequency a small number of cycles. One frequency corresponds to key closed and the other frequency to key open.

Centigrade—The temperature scale in which water boils at 100 degrees and freezes at 0 degrees; ordinarily abbreviated as C.

Current limiting resistor—A series resistor which will take almost the full voltage drop of the power source if the component with which it is in series drops to a low impedance.

Dot cycles per second—A measure of the equivalent frequency band covered by the keying of teletypewriter code signals.

Decoupling capacitor—A bypass capacitor so placed in a circuit that the a-f or r-f currents of that circuit are prevented from going into the power supply or to another stage on the common voltage supply.

Decoupling resistor—A resistor used in a filter network to prevent the a-f or r-f currents in the network from appearing in the B+ or common voltage supply lead.

Dynamic mutual conductance tube tester—A tube checker that tests tubes with an a-c signal applied to the grid and gives readings that are directly related to the mutual conductances of the tube. This is not the same as the check of an emission type tester.

Frequency shift keying—A method of sending c-w signals where one frequency corresponds to key-closed conditions and another, separated by an audio amount, to key-open conditions. Usually the keying is by teletypewriter. (Same as carrier shift keying.)

Full DX—An extension circuit that can be operated in both directions simultaneously.

Gating tube—A tube which will not allow another tube to be keyed unless it has the proper bias applied.

Half DX—A series extension circuit that can receive or transmit at one position; cannot do both simultaneously.

Hypersil core—A special silicon steel transformer core.

Keying polarity—The d-c pulses arriving from a teletypewriter keyboard (or tape transmitter) are either positive with respect to ground or negative with respect to ground, in neutral keying. This is their polarity.

Lissajous figures—Symmetrical designs on an oscilloscope screen showing the frequency ratio of two applied voltages.

Low-pass filter—An r-f filter circuit which strongly attenuates all frequencies above a certain frequency. Often used for harmonic suppression.

Loop—A closed extension circuit, generally containing one or more TT components.

Mark—Closed key condition on a teletypewriter circuit.

Mark frequency—The frequency of the signal emitted by a frequency shifting oscillator or a transmitter which corresponds to the closed key condition of the teletypewriter circuit.

Neon coupling tube—A neon bulb used for coupling between two stages. When the neon tube is ionized, there is a high positive voltage applied to the grid of the second tube. When the neon tube is deionized, there is no coupling between the two stages.

Neutral keying—Square-wave d-c pulses which have a single polarity with respect to ground. The individual pulses correspond to the mark contact closures of the associated teletypewriter equipment.

Oven cycling—The heater off and on switching by the thermostatic control.

Polar keying—A system of d-c keying where pulses of one polarity (with respect to ground) are mark signals (closed key) and the opposite polarity are space signals (open key).

Reactance tube—A tube across an oscillator circuit which effectively puts capacitive reactance into the oscillator frequency determining section to change the output frequency of the oscillator. The reactance tube is keyed by changing the bias on it.

Shift—The number of cycles between the mark and space (closed and open key) frequencies.

Solvent (SD)—A dry-cleaning solvent used for cleaning greasy surfaces.

Space—The keying line condition corresponding to open key on a teletypewriter circuit.

Space frequency—The frequency of the signal emitted by a frequency shifting oscillator or a transmitter which corresponds to the open key condition of the teletypewriter circuit.

Spurious output—Harmonics, parasitics, and other undesired frequencies in the r-f output of an r-f oscillator, signal generator, or transmitter.

Striking voltage—The voltage at which a gas-filled tube ionizes.

Stripping—The removal of all plug-in parts before checking a unit. If the unit is going to be salvaged, this means removal of all units (including wired-in and bolted-in units) that may be useful for replacement purposes.

Test key—A key on the front panel of an equipment used to key an oscillator or a transmitter. The keying circuit may simulate a long external line or a special keying voltage and should result in the same transmitted output as would be caused by the remote keying device.

Varistor—A resistor which changes resistance when the applied voltage is changed.

Voltage reference tube—A gaseous regulator tube that is used to give an unvarying voltage to a tube element, such as a grid or cathode (replaces a bias battery).

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning of Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as a specific T/O&E, T/A, SIG 7 & 8, list of allowances of expendable material, or another authorized supply basis. The Department of the Army Supply Catalog applicable to the equipment covered in this manual is SIG 7 & 8 C–292/TRA–7. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1.

2. Identification Table Parts

Ref symbol	Model			Name of part and description	Function of part	Signal Corps stock No.
	C–292/TRA–7	C–292A/TRA–7	C–292B/TRA–7			
				CONTROL UNITS C–292/TRA–7 and C–292A/TRA–7: 115 v AC, 50–60 cyc; 19″ wd x 4⅛″ d x 10½″ h o/a; mts in std rack or cabinet; steel case.	Converts polar signals into neutral signals and provides neutral dc pulses for operating TT machines locally or at a distance through telegraph repeaters.	2C684–292
				CONTROL UNIT C–292B/TRA–7: 115 v AC, 50–60 cyc, 1 ph; mts in std rack in cabinet.	Converts polar signals into neutral signals and provides neutral d-c pulses for operating TT machines.	2C684–292B
			*	TECHNICAL MANUAL TM 11–264.....	Describes use of control unit in Radio Set AN/GRC–26.	(Order through AGO channels)
	*	*	*	TECHNICAL MANUAL TM 11–624.....	Describes use of control unit in Radio Sets AN/MRC–2 and AN/MRC–2A.	(Order through AGO channels)
	*	*	*	BAR, actuator, electrical switch: 1¼″ lg x 11/16″ wd x ½″ h; Hallicrafters part/dwg #30B202.	TRANSMITTER switch bar (for S109 and S110).	2Z558–64
E101	*	*	*	BOARD, terminal: 62 metal stud term; 16″ lg x 3″ wd x ½″ thk; Hallicrafters part/dwg #88–20.	For mounting resistors and capacitors.	3Z770–62.3
E102	*	*	*	BOARD, terminal: 60 term, turret type; 16″ lg x 3″ wd x ½″ thk; Hallicrafters part/dwg #88–719.	Mounts components.....	3Z770–60.11
E103	*			BOARD, terminal: 54 metal stud term; 10–¼″ lg x 3″ wd x ⅛″ thk; WECo #B–461820.	For mounting resistors and capacitors.	2Z9440–176
E103		*	*	BOARD, terminal: 56 metal turret term lugs; 13″ lg x 3″ h x ½″ thk; Hallicrafters part /dwg #88–718.	Mounts resistors and capacitors.	3Z770–56.6

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
C104, C108	*	*	*	CAPACITOR, fixed: ceramic; 240 uuf, ±5%; 500 vdcw; JAN type CC36SL241J.	C104: Prevents V114 from oscillating. C108: Prevents V115 from oscillating.	3D9240–30
C101	*	*	*	CAPACITOR, fixed: paper; 20,000 uuf ±-10%; 600 vdcw; JAN type CP26A1EF203K.	Sustains grid of V101 at potential of last previous pulse.	3DA20–167
C105, C109	*	*	*	CAPACITOR, fixed: paper; 500,000 uuf ±-20% —10%; 600 vdcw; JAN type CP54B1-EF504V.	C105: Couples +300-volt output ripple to control tube cathode. C109: Couples —150-volt output ripple to control tube grid.	3DA500–664
C106, C110	*	*	*	CAPACITOR, fixed: paper; 2 uf ±10%; 600 vdcw; JAN type CP54B1EF205K.	C106: +300-volt high-frequency shunt. C110: —150-volt high-frequency shunt.	3DB2–154
C111	*	*	*	CAPACITOR, fixed: paper; 4 uf ±10%; 600 vdcw; JAN type CP41B1EF405K.	—300-volt output filter.....	3DB4–264
C107	*	*	*	CAPACITOR, fixed: electrolytic; 80 uf min; 450 vdcw; JAN type CE41F800R.	—150-volt filter.....	3DB80–14
C102, C103	*	*	*	CAPACITOR, fixed: electrolytic; 120 uf; 350 vdcw; JAN type CE41C121P.	+300-volt filters.....	3DB120–4
	*	*	*	CLAMP, electrical: aluminum; .767″ lg x .38″ wd x .375″ h o/a; mtd by one .173″ dia mtg hole; designed to hold material 5/16″ max dia; neoprene coated; Tinnerman Prod type A3049–5; Hallicrafters part/dwg #76–735.	Secures cable to chassis.....	2Z2642.522
	*	*	*	CLAMP, electrical: aluminum; 3/16″ lg x 3/8″ wd x .375″ h; mtd by 1 mtg hole .173″ dia; designed to hold material 1/4″ max dia; neoprene coated; Tinnerman Prod type A3049–4; Hallicrafters part/dwg #76A-689.	Secures electrical conductors to chassis.	2Z2642.497
	*	*	*	CLAMP, electrical: steel; 2 1/8″ lg x 1 1/2″ wd x 1″ h o/a; mtd by 2 mtg holes .140″ dia spaced 1 5/16″ c to c; Goat Metal type G–1202–4; Hallicrafters part dwg #69A389.	Holds tube shield.....	2Z2642.523
	*	*	*	COLLAR, spacing: brass, cad coated; long cylindrical shape; 2 3/16″ lg x 3/8″ dia; single axial tapped mtg hole w/#8–32 thd, 1″ lg at ea end; Hallicrafters part/dwg #73–648.	Used for mounting purposes.....	2Z2935–157
J103	*	*	*	CONNECTOR, receptacle: 5 round female pol cont; straight; ANA type AN–3102A–14S–5S.	Receives Cord CX–956/TRA–7 from extension circuits.	2Z3066–93

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
J107	*	*	*	CONNECTOR, receptacle: 3 curved pol male cont; straight type; Hubbell #7556G.	Receives Cord CX-962/TRA-7 from a-c power source.	6Z7813-8
J101	*	*	*	CONNECTOR, receptacle: 4 round pol male cont; straight; ANA type AN-3102A-14S-10P.	Receives Cord CX-957/TRA-7 from dual-diversity converter.	2Z3024-107
J102	*	*	*	CONNECTOR, receptacle: 4 round pol male cont; straight; ANA type AN-3102A-14S-11P.	Receives Cord CX-958/TRA-7 from frequency-shift exciter.	2Z3024-106
	*	*	*	FASTENER, latch: 2 3/16" lg x 1 1/16" wd x 7/8" h; corbin cabinet #15631.	For cabinet.....	6Z1747-12
F101, F102	*	*	*	FUSE FU-50; 3 amp, 250 v.....	Protect power transformers....	3Z1950
X119, X120	*	*	*	FUSEHOLDER: extractor post type; for 1 #3AG cartridge fuse; Buss HKP-BL.	Hold fuses.....	3Z3285-6.7
	*	*	*	INSULATOR, bushing: plastic; brown; dim., MBCA ref dwg Group 9, D-3/4", E-1/32", G-7/16"; H-7/32", L-7/8"; one 7/32" dia mtg hole; Hallicrafters part/dwg #8-1426.	Used between resistor and chassis.	3G100-226
	*	*	*	INSULATOR, plate: phenolic; black; flat, rectangular shape; MBCA ref dwg group 9, dim., L-1 7/8", M-#27" drill, Q-1 1/4", T-1/16", W-1 1/16"; two #27 drill holes spaced 1 1/4" c to c; Hallicrafters part/dwg #8A341.	Used between interlock switch and chassis.	3G320-299
	*	*	*	INSULATOR, plate: plastic; flat, rectangular shape; MBCA ref dwg group 9, dim., L-2-3/4", W-3/8", K-7/16", J-center line; Q-1.875", T-3/16", N-.180"; two .180" dia holes spaced 1.875" c to c; Hallicrafters part/dwg #8B1667.	Terminal board to chassis insulator.	3G320-310
	*	*	*	KNOB: black bakelite; for 1/4" dia shaft; white indicator line; Molded Insul K-868-236-1.	For use on EXTENSION CURRENT, SENDING LINE CURRENT, SPACE and MARK controls.	2Z5822-167
	*	*	*	KNOB: black bakelite; for 1/4" dia shaft; white indicator line; Molded Insul P-712-336-5.	For use on SERVICE, METER, and OPERATION controls.	2Z5822-166
I101, I102	*	*	*	LAMP LM-52: 6 to 8 v; .15 amp; miniature bayonet type.	I101: TRANSMITTER indicator. I102: AC SUPPLY indicator.	2Z5952
	*	*	*	LENS, indicator light: green; Dialco #DP-H.	Lens for TRANSMITTER indicator.	2Z5991-78

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
	*	*	*	LENS, indicator light: white; Dialco DP–H.	Indicator lens for AC SUPPLY.	2Z5991–79
X118	*	*	*	LIGHT, indicator: w/green lens; for miniature bayonet base lamp; Dialco 932210–112.	TRANSMITTER indicator lamp mounting.	2Z5991–80
X117	*	*	*	LIGHT, indicator: w/white lens; for miniature bayonet base lamp; Dialco 932210–117.	AC SUPPLY indicator lamp mounting.	2Z5991–81
M101	*	*	*	METER, ammeter: DC; 100–0–100 ua; JAN type MR26W101DCUA.	Measures circuit currents and balance voltage.	3F1100–5
	*	*	*	PLATE, electrical switch: 5/16″ lg x .242″ wd x 1/8″ thk; one #4–40 tapped mtg hole in ctr of bar; Hallicrafters part/dwg #73B616.		2Z7091–601
	*	*	*	POST, binding: brass cap, nickel pl; brass base, nickel pl; 21/32″ o/a height of post, above mtg surface; 27/64″ OD; w/o mtg stud; tapped, #6 3/16″ d, 32 thd per in; 1/8″ max dia of wire hole; type 6697; Hallicrafters part/dwg #11B327.	Retains #8 Allen wrench.....	3Z737–4.9
R188	*		*	RESISTOR, fixed: WW; .10 ohm ±.5%; 1/2 w; JAN type RB12BR1000D.	Filament voltage-dropping resistor for V104, V106, and and V107.	3RB1–1000
R151, R152	*	*	*	RESISTOR, fixed: WW; 15 ohms ±1%; 1/4 w; JAN type RB51B15R00F.	R151: M101 shunt for SEND EXT-CURRENT. R152: M101 shunt for REC EXT-CURRENT.	3RB3–1500
R182, R183	*	*	*	RESISTOR, fixed: WW; 31 ohms ±5%; 5 w; JAN type RW55J310.	R182: V112 cathode..... R183: V113 cathode.....	3RW15337
R101, R153	*	*	*	RESISTOR, fixed: WW; 36 ohms ±1%; 1/4 w; JAN type RB51B36ROOF.	R101: Meter M101 shunt for REC LINE CURRENT. R153: Meter M101 shunt for SEND LINE CURRENT.	3RB3600
R164, R174, R175	*	*	*	RESISTOR, fixed: comp; 47 ohms ±10%; 1/2 w; JAN type RC20BF470K.	R164: V111 screen parasitic resistor. R174: V113 screen parasitic resistor. R175: V112 screen parasitic resistor.	3RC20BF470K
R130, R131, R161	*	*	*	RESISTOR, fixed: WW; 500 ohms ±5%; 5 w; JAN type RW55J501.	R130: V104 plate current limiting. R131: Receive extension current limiting. R161: Send extension current limiting.	3RW22518

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
R150	*	*	*	RESISTOR, fixed: WW; 1000 ohms ±5%; 9 w; JAN type RW56J102.	FS control line current limiting.	3RW24328
R108	*	*	*	RESISTOR, fixed: comp; 1100 ohms ±5%; 2 w; JAN type RC42BE112J.	Par of V104 screen voltage divider.	3RC42BE112J
R144	*	*	*	RESISTOR, fixed: WW; 1600 ohms ±5%; 5 w; JAN type RW55J162.	V106 plate load	3RW25513
R149	*	*	*	RESISTOR, fixed: WW; 1600 ohms ±5%; 9 w; JAN type RW56J162.	V104 plate current limiting during emergency c-w operation.	3RW25515
R134	*	*	*	RESISTOR, fixed: WW; 1600 ohms ±5%; 30 w; JAN type RW34G162.	Send extension current limiting during normal full-duplex operation.	3RW25514
R148	*	*	*	RESISTOR, fixed: WW; 2000 ohms ±5%; 12 w; JAN type RW32G202.	Receive extension current limiting during emergency c-w operation.	3RW26109
R166, R177, R178	*	*	*	RESISTOR, fixed: comp; 2200 ohms ±10%; ½ w; JAN type RC20BF222K.	R166: V111 grid current limiting. R177: V113 grid current limiting. R178: V112 grid current limiting.	3RC20BF222K
R132	*	*	*	RESISTOR, fixed: WW; 4000 ohms ±5%; 5 w; JAN type RW55J402.	Part of —150-volt divider for send extension current during full-duplex operation.	3RW27918
R190			*	RESISTOR, fixed: comp; 4300 ohms ±5%; 1 w; JAN type RC30BF432J.	V117 current limiting resistor.	3RC30BF432J
R111	*	*	*	RESISTOR, fixed: comp; 6200 ohms ±5%; 1 w; JAN type RC30BF622J.	Part of V104 screen voltage divider.	3RC30BF622J
R133	*	*	*	RESISTOR, fixed: WW; 6300 ohms ±5%; 9 w; JAN type RW56J632.	Part of —150-volt divider for send extensions current during full-duplex operation.	3RW29113
R186	*	*	*	RESISTOR, fixed: WW; 8000 ohms ±5%; 18 w; JAN type RW33G802.	V116 current limiting	3RW29713
R142	*	*	*	RESISTOR, fixed: comp; 8200 ohms ±5%; 2 w; JAN type RC42BE822J.	Part of V106 screen voltage divider.	3RC42BE822J
R112, R122, R135, R145	*	*	*	RESISTOR, fixed: comp; 10,000 ohms ±10%; 1 w; JAN type RC30BF103K.	R112: V101 screen voltage dropping. R122: V103 screen voltage dropping. R135: V107 screen voltage dropping. R145: Part of V105 screen voltage divider.	3RC30BF103K

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
R156			*	RESISTOR, fixed, film: 12,000 ohms ±1%; ½ w; deposited carbon film on ceramic rod; Hallicrafters part/dwg #23A076.	M101 series multiplier.....	3Z6612–79
R156		*		RESISTOR, fixed: comp; deposited film type; 12,000 ohms ±1%; 1 w; Concarbon #Nobleloy X–1.	M101 series multiplier.....	3Z6612–57
R156	*			RESISTOR, fixed: WW; 12,000 ohms ±1%; 1 w; WECo #D–162747A.	M101 series multiplier.....	3Z6612–56
R104	*	*	*	RESISTOR, fixed: comp; 12,000 ohms ±5%; ½ w; JAN type RC20BF123J.	T101 secondary shunt.....	3RC20BF123J
R189			*	RESISTOR, fixed: comp; 12,000 ohms ±5%; 1 w; JAN type RC30BF123J.	—150-volt supply voltage divider resistor in V115 grid network.	3RC30BF123J
R109	*	*	*	RESISTOR, fixed: comp; 13,000 ohms ±5%; 2 w; JAN type RC42BE133J.	Part of V104 screen voltage divider.	3RC42BE133J
R117, R118	*	*	*	RESISTOR, fixed: comp; 20,000 ohms ±5%; ½ w; JAN type RC20BF203J.	V102 biasing voltage dividers...	3RC20BF203J
R184, R185	*	*	*	RESISTOR, fixed: comp; 20,000 ohms ±5%; 2 w; JAN type RC42BF203J.	V115 cathode (pin 6) biasing voltage dividers.	3RC42BF203J
R168	*	*	*	RESISTOR, fixed: comp; 27,000 ohms ±10%; ½ w; JAN type RC20BF273K.	Part of V114 cathode (pin 6) biasing voltage divider.	3RC20BF273K
R147	*	*	*	RESISTOR, fixed: comp; 27,000 ohms ±10%; 2 w; JAN type RC42BE273K.	Part of V105 screen voltage divider.	3RC42BE273K
R167, R179	*	*	*	RESISTOR, fixed: comp; 33,000 ohms ±10%; 1 w; JAN type RC30BF333K.	R167: Prevents V114 from oscillating. R179: Prevents V115 from oscillating.	3RC30BF333K
R191			*	RESISTOR, fixed: comp; 39,000 ohms ±5%; 1 w; JAN type RC30BF393J.	Part of voltage divider for V115 grid.	3RC30BF393J
R125	*	*	*	RESISTOR, fixed: comp; 43,000 ohms ±5%; 2 w; JAN type RC42BE433J.	Part of V103 plate voltage divider (balancing network).	3RC42BE433J
R102, R106	*	*	*	RESISTOR, fixed: comp; 47,000 ohms ±5%; 1 w; JAN type RC30BF473J.	R102: V101 grid current limiting. R106: Part of V101 grid feedback voltage divider (balance circuit).	3RC30BF473J
R114, R124, R127, R140	*	*	*	RESISTOR, fixed: comp; 47,000 ohms ±10%; 2 w; JAN type RC42BE473K.	R114: Part of V101 plate load. R124: Part of V103 plate load. R127: Part of V103 plate voltage divider (balance network). R140: Part of V107 plate load.	3RC42BE473K

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
R173	*	*	*	RESISTOR, fixed: comp; 51,000 ohms ±5%; 1 w; JAN type RC30BF513J.	Part of V114 cathode (pin 3) biasing voltage divider.	3RC30BF513J
R113, R123, R141	*	*	*	RESISTOR, fixed: comp; 51,000 ohms ±5%; 2 w; JAN type RC42BE513J.	R113: Part of V101 plate load. R123: Part of V103 plate load. R141: Part of V107 plate load.	3RC42BE513J
R129	*	*	*	RESISTOR, fixed: comp; 62,000 ohms ±5%; 1 w; JAN type RC30BF623J.	Part of V104 grid voltage divider during one-way or half-duplex operation.	3RC30BF623J
R107	*	*	*	RESISTOR, fixed: comp; 68,000 ohms ±5%; 1 w; JAN type RC30BF683J.	Part of V101 grid feedback voltage divider (balance circuit).	3RC30BF683J
R128, R139	*	*	*	RESISTOR, fixed: comp; 75,000 ohms ±5%; 2 w; JAN type RC42BE753J.	R128: Part of V104 grid voltage divider (balance circuit). R139: Part of V106 grid voltage divider.	3RC42BE753J
R138	*	*	*	RESISTOR, fixed: comp; 82,000 ohms ±5%; 2 w; JAN type RC42BE823J.	Part of V106 grid voltage divider.	3RC42BE823J
R169	*	*	*	RESISTOR, fixed: comp; 120,000 ohms ±10%; 1 w; JAN type RC30BF124K.	Part of V114 voltage divider (cathode biasing).	3RC30BF124K
R171	*	*	*	RESISTOR, fixed: comp; 150,000 ohms ±10%; 2 w; JAN type RC42BE154K.	Part of V114 cathode (pin 3) biasing voltage divider.	3RC42BE154K
R121	*	*	*	RESISTOR, fixed: comp; 180,000 ohms ±5%; 2 w; JAN type RC42BE184J.	Part of V102 voltage biasing divider.	3RC42BE184J
R119	*	*	*	RESISTOR, fixed: comp; 220,000 ohms ±5%; 1 w; JAN type RC30BF224J.	Part of V102 voltage biasing divider.	3RC30BF224J
R155	*			RESISTOR, fixed: film; 300,000 ohms ±1%; ½ w; WECo. spec D-164900A.	M101 multiplier, BALANCE position.	3Z6730-38
R155		*		RESISTOR, fixed: deposited carbon film on ceramic rod; 300,000 ohms ±1%; 2 w; Concarbon #Nobleloy X-2.	M101 multiplier, BALANCE position.	3Z6730-43
R155			*	RESISTOR, fixed: 300,000 ohms ±1%; 1 w; deposited carbon film on ceramic rod; Hallicrafters part/dwg #23A077.	M101 multiplier, BALANCE position.	3Z6730-59
R120	*	*	*	RESISTOR, fixed: comp; 360,000 ohms ±5%; 1 w; JAN type RC30BF364J.	Part of V102 voltage biasing divider.	3RC30BF364J
R170, R180	*	*	*	RESISTOR, fixed: comp; 470,000 ohms ±10%; ½ w; JAN type RC20BF474K.	R170: V114 plate (pin 2) load. R180: V115 plate (pin 2) load.	3RC20BF474K
R105	*	*	*	RESISTOR, fixed: comp; 680,000 ohms ±10%; 1 w; JAN type RC30BF684K.	V101 grid feedback coupling (from balance network).	3RC30BF684K

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
R158, R159	*	*	*	RESISTOR, fixed: comp; 1 meg ±10%; ½ w; JAN type RC20BF105K.	R158: —300 VOLT SUPPLY shunt for M101. R159: +300 VOLT SUPPLY shunt for M101.	3RC20BF105K
R162, R163	*	*	*	RESISTOR, fixed: comp; 1 meg ±10%; 2 w; JAN type RC42BE105K.	Voltage equalizing for C102 and C103.	3RC42BE105K
R136	*	*	*	RESISTOR, fixed: comp; 1.2 meg ±5%; ½ w; JAN type RC20BF125J.	Part of V107 grid voltage divider during one-way and half-duplex operation.	3RC20BF125J
R115	*	*	*	RESISTOR, fixed: comp; 1.5 meg ±5%; ½ w; JAN type RC20BF155J.	Part of V103 grid voltage divider.	3RC20BF155J
R154	*			RESISTOR, fixed: comp; 2 meg ±1%; 1 w; WECo spec D-169202A.	—150 VOLT SUPPLY multiplier for M101.	3Z6802-54
R154		*	*	RESISTOR, fixed: comp; 2 meg ±1%; 2 w; Hallicrafters part/dwg #23A078.	—150 VOLT SUPPLY multiplier for M101.	3Z6802-37
R103, R116, R137, R165, R176	*	*	*	RESISTOR, fixed: comp; 2.2 meg ±5%; ½ w; JAN type RC20BF225J.	R103: Part of V101 grid voltage divider. R116: Part of V103 grid voltage divider. R137: Part of V107 grid voltage divider during one-way and half-duplex operation. R165: V114 plate (pin 5) load. R176: V115 plate (pin 5) load.	3RC20BF225J
R157, R160	*			RESISTOR, fixed: deposited film type 4 meg ±1%; 2 w; Concarbon #Nob e oy X-2.	R157: —300 VOLT SUPPLY multiplier for M101. R160: +300 VOLT SUPPLY multiplier for M101.	3Z6804-19
R157, R160		*	*	RESISTOR, fixed: comp; 4 meg ±1%; 2 w; Hallicrafters part/dwg #23A079.	R157: —300 VOLT SUPPLY multiplier for M101. R160: +300 VOLT SUPPLY multiplier for M101.	3Z6804-2
R172, R181	*	*		RESISTOR, variable: comp; 25,000 ohms; 2 w; JAN type RV4APSA253B.	R172: +300 V ADJ control. R181: —150 V ADJ control.	3RV42509
R110	*	*		RESISTOR, variable: comp; 25,000 ohms ±20%; 2 w; JAN type RV4APFK253B.	EXTENSION CURRENT control.	3RV42504
R110			*	RESISTOR, variable: comp; 25,000 ohms ±10%; 2 w; JAN type RV4ANFK253A.	EXTENSION CURRENT control.	3RV42524
R172, R181			*	RESISTOR, variable: comp; 25,000 ohms ±20%; 2 w; JAN type RV4ANSD253A.	R172: +300V ADJ control. R181: —150V ADJ control.	3RV42502
R126	*	*		RESISTOR, variable: comp; 50,000 ohms ±20%; 2 w; JAN type RV4APSA503B.	BALANCE ADJ control.....	3RV45006

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
R143, R146	*	*		RESISTOR, variable: comp; 50,000 ohms ±20%; 2 w; JAN type RV4APFK503B.	R143: SENDING LINE CURRENT SPACE control. R146: SENDING LINE CURRENT MARK control.	3RV45018
R126			*	RESISTOR, variable: comp; 50,000 ohms ±10%; 2 w; JAN type RV4ANSD503A.	BALANCE ADJ control.....	3RV45031
R143, R146			*	RESISTOR, variable: comp; 50,000 ohms ±10%; 2 w; JAN type RV4ANFK503A.	R143: SENDING LINE CURRENT SPACE control. R146: SENDING LINE CURRENT MARK control.	3RV45033
	*	*	*	RETAINER, electron tube: asbestos and phosphor bronze; cad pl and irridite protective finish on metal parts; 1⅛″ h min x 3⅜″ h max x 1¼″ dia max; mtd by two 3/16″ dia holes 1⅞″ c to c accom mtg posts 3/16″ dia x 3⅜″ lg w/10–32 thd hole 27–32″ d in bottom end; WECo #D–152558–B; Hallicrafters part/dwg #76–693.	Holds and retains tube steady in socket.	2Z7780–20
	*	*	*	RETAINER, electron tube: asbestos and phosphor bronze; cad pl and irridite protective finish on metal parts; 2″ h min x 4¼″ h max x 1⅝″ dia max; mtd by four 3/16″ dia holes on ⅞″ x 2 3/16″ ctr accom mtg posts 3/16″ dia x 4⅜″ lg w/10–32 thd hole ⅞″ d in bottom end; WECo #D–152560; Hallicrafters part/dwg #76–732.	Holds and retains tube steady in socket.	2Z7780–19
	*	*	*	RETAINER, tube: designed to retain tubes 2″ h min x 3¾″ h max x 1½″ dia max; WECo #D–152559–B.	Holds vacuum tubes V104, V111, V112, and V113 steady in sockets.	2Z7780–37
	*	*	*	SHIELD, capacitor: 5″ lg x 1¾″ dia; B & W dwg #WE–A–2810–9.	Shields C111.....	2Z8309–8
	*	*	*	SHIELD, tube: friction mtd; 2 25/32″ lg x 1 9/32″ dia; Goat Metal type G1222A.	Shields V105 and V106.....	2Z8304.291
	*	*	*	SHOCK MOUNT M–449: sq mtg; 2⅜″ x 2⅜″.	Protects equipment against vibration.	2Z8415–449
X101 thru X117	*	*	*	SOCKET, tube: octal; 1 piece under chassis mtg; JAN type TSB101P01.	For mounting tubes V101 through V117 (V117 in B model only).	2Z8670.33
S101, S103	*	*	*	SWITCH, push-button: SPST; normally open; AH & H #81075–E.	S101: RECEIVING TEST SPACE switch. S103: RECEIVING TEST MARK switch.	3Z9824–31.67
S106, S107	*	*	*	SWITCH, interlock: SPST, male and female; GE #7460330G4 and 7460330G7.	Door safety interlocks.....	3Z9560–7

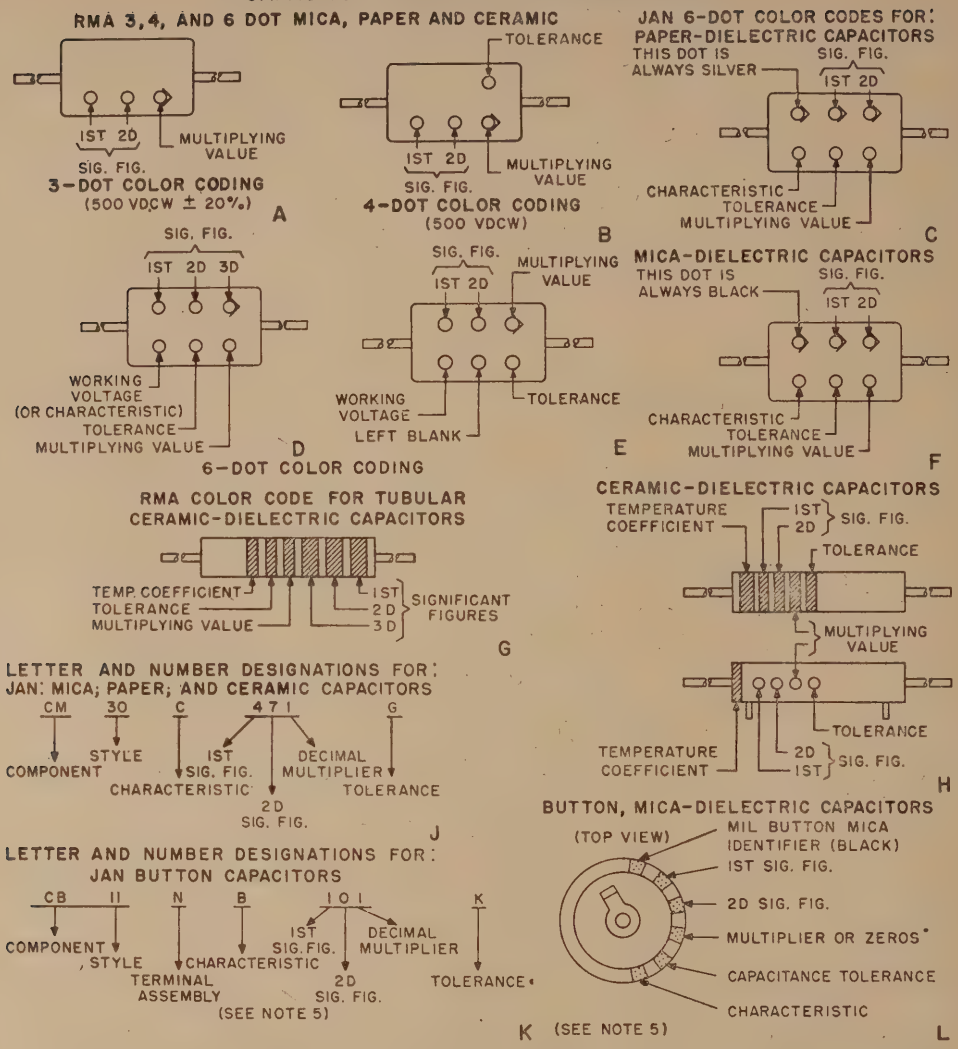
2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
S105	*	*	*	SWITCH, rotary: 8 position; 3 sect; 1 pole, 8 throws; Oak #DH.	Selects circuit for inserting meter.	3Z9825–62.668
S102	*	*	*	SWITCH, rotary: 4 ckt 3 throws; Oak #DH.	Selects type of service.....	3Z9825–62.669
S104	*	*	*	SWITCH, rotary: 3 position; 2 sect; 4 pole, 3 throws; Oak #DH.	Selects type of operation.....	3Z9825–62.670
S108, S109, S110	*	*	*	SWITCH, toggle: DPST; JAN type ST52K..	S108: A-c SUPPLY switch S109 and S110: TRANSMITTER ON switch.	3Z9863–52K
T101	*	*	*	TRANSFORMER, AF: input type; pri 73-ohm Dc res, secd 4100-ohm DC res; pri 900-ohms impedance, secd 40,500 ohms impedance; HS steel case; $4\frac{9}{32}$″ lg x $3\frac{15}{32}$″ wd x $1\frac{3}{4}$″ h; Chi Trans spec #14309.	Couples single input to V101 and V102.	2Z9631.441
T103			*	TRANSFORMER, power: fil and pl type; pri 115 v, 50/60 cps, 2 wnd; secd #1 600 v at .20 amp CT (rms); #2, 6.4 v at 1.85 amp; #3, 5.1 v at 2.0 amp; HS metal case; Chi Trans spec #14307.	Supplies —150-volt power.....	2Z9613.675
T102	*	*	*	TRANSFORMER, power step-up and step-down: HS metal case; two 115 v, 50 to 60 cyc single phase input wnd; 4 output wnd, #1 secd 720 v CT, 90 ma rms, 60 ma DC full wave; #2 secd 6.4 v, 600 ma rms; #3 secd 6.4 v, 2.6 amp rms; #4 secd 6.4 v, 4.0 amp rms; 1750 v insulation; $4\frac{1}{2}$″ lg x $3\frac{3}{8}$″ wd x $5\frac{1}{4}$″ h; 13 solder lug term, located on bottom; integral mtg studs $\frac{1}{4}$–20 x $\frac{3}{4}$″ lg on $3\frac{7}{16}$″ x $2\frac{1}{2}$″ mtg/c; Military spec MIL–T–27, type group 1, class A; Chi Trans spec #14308; Hallicrafters part/dwg #52C230.	Supplies —300- and +300-volt power.	2Z9621–386
T103	*	*		TRANSFORMER, power: fil and pl type; input 115 v, 50/60 cps, single ph; secd #1, 600 v at .19 amp CT; #2, 6.4 v at 1.85 amp; #3, 5.1 v at 2.0 amp; completely encl metal case; EWCo spec KS–13118.	Supplies —150-volt power.....	2Z9613.522
V116	*	*	*	TUBE, electron: JAN type #OD3.....	Regulates —300 volt output....	2JOD3
V117			*	TUBE, electron: JAN type #OC3.....	Voltage reference tube for V115 cathode.	2JOC3
V109	*	*	*	TUBE, electron: JAN type #5R4WGY.....	—150-volt rectifier.....	2J5R4WGY
V102	*	*	*	TUBE, electron: JAN type #6H6.....	Limits incoming signal peaks...	2J6H6

2. Identification Table Parts (Continued)

Ref symbol	Model C-292/TRA-7	Model C-292A/TRA-7	Model C-292B/TRA-7	Name of part and description	Function of part	Signal Corps stock No.
V101, V103, V107	*	*	*	TUBE, electron: JAN type #6SJ7Y.....	V101: Switches mark or space incoming signals. V103: Locks incoming signals. V107: Supplies neutral sending signals.	2J6SJ7Y
V114, V115	*	*	*	TUBE, electron: JAN type #6SL7GT.....	V114: +300-volt control tube. V115: —150-volt control tube.	2J6SL7GT
V105, V106	*	*	*	TUBE, electron: JAN type #6V6GTY.....	V105: Supplies polar mark output signals. V106: Supplies polar space output signals.	2J6V6GTY
V108, V110	*	*	*	TUBE, electron: JAN type #6X5GT.....	V108: +300-volt rectifier..... V110: —300-volt rectifier.	2J6X5GT
V104, V111, V112, V113	*	*	*	TUBE, electron: JAN type #6Y6G.....	V104: Supplies receiving output extension current. V111: +300-volt regulator. V112: —150-volt regulator. V113: —150-volt regulator.	2J6Y6G
R187	*	*	*	VARISTOR: WECo spec #D–172309.....	Part of voltage regulation system, used as voltage standard in power supply.	4Z9750–1
	*	*	*	WRENCH: $\frac{5}{64}$″ across flats; $\frac{45}{64}$″ x $1\frac{31}{32}$″ lg, steel, cad plate and iridite; L shape; straight handle, solid hex. type; for #8 Allen setscrew and #4 Allen cap screw; Allen Mfg #8; Hallicrafters part/dwg #33B428; Sig C dwg #SC–B–2399.	For turning setscrews or cap screws.	6R57400

CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
									CAP. TOL. FOR MORE THAN 10 UUF			CAP. TOL. FOR 10 UUF OR LESS		
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARAC-TERISTIC	LETTER TOL.	CHARAC-TERISTIC	DEC. MULT.	%	LETTER DESIG-NATION	UUF	LETTER DESIG-NATION	CHARAC-TERISTIC
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300*	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	± 5	500	-	F	-	R	-	± 5	J	±0.5	D	S
BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-

* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%

NOTES

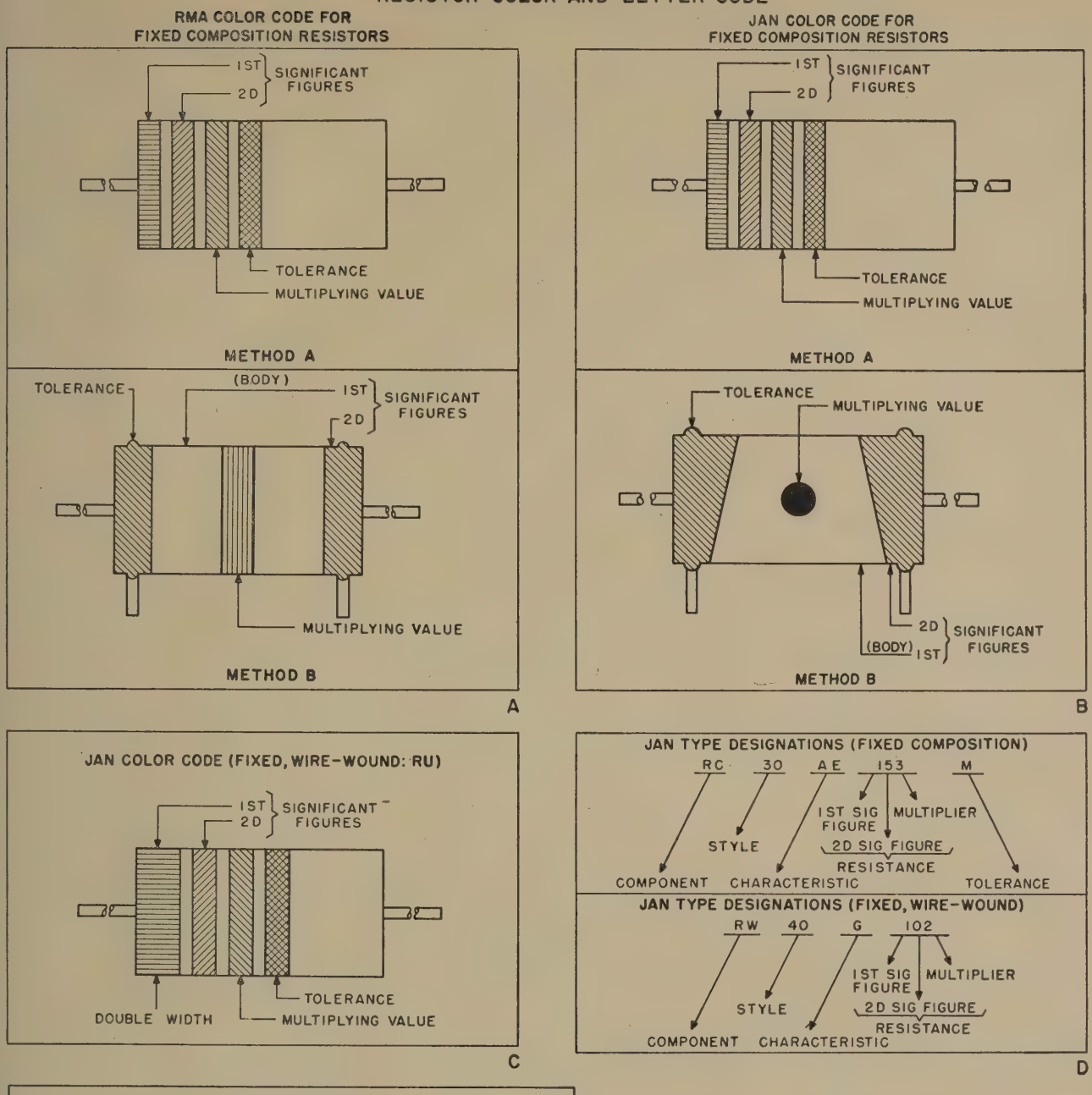
JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION

1. THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
2. THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
3. CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
4. BUTTON CAPACITORS ARE GENERALLY 300 VDCW
5. READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
6. CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
7. THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
   CB MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

TM CC

Figure 31. Capacitor color codes.

RESISTOR COLOR AND LETTER CODE



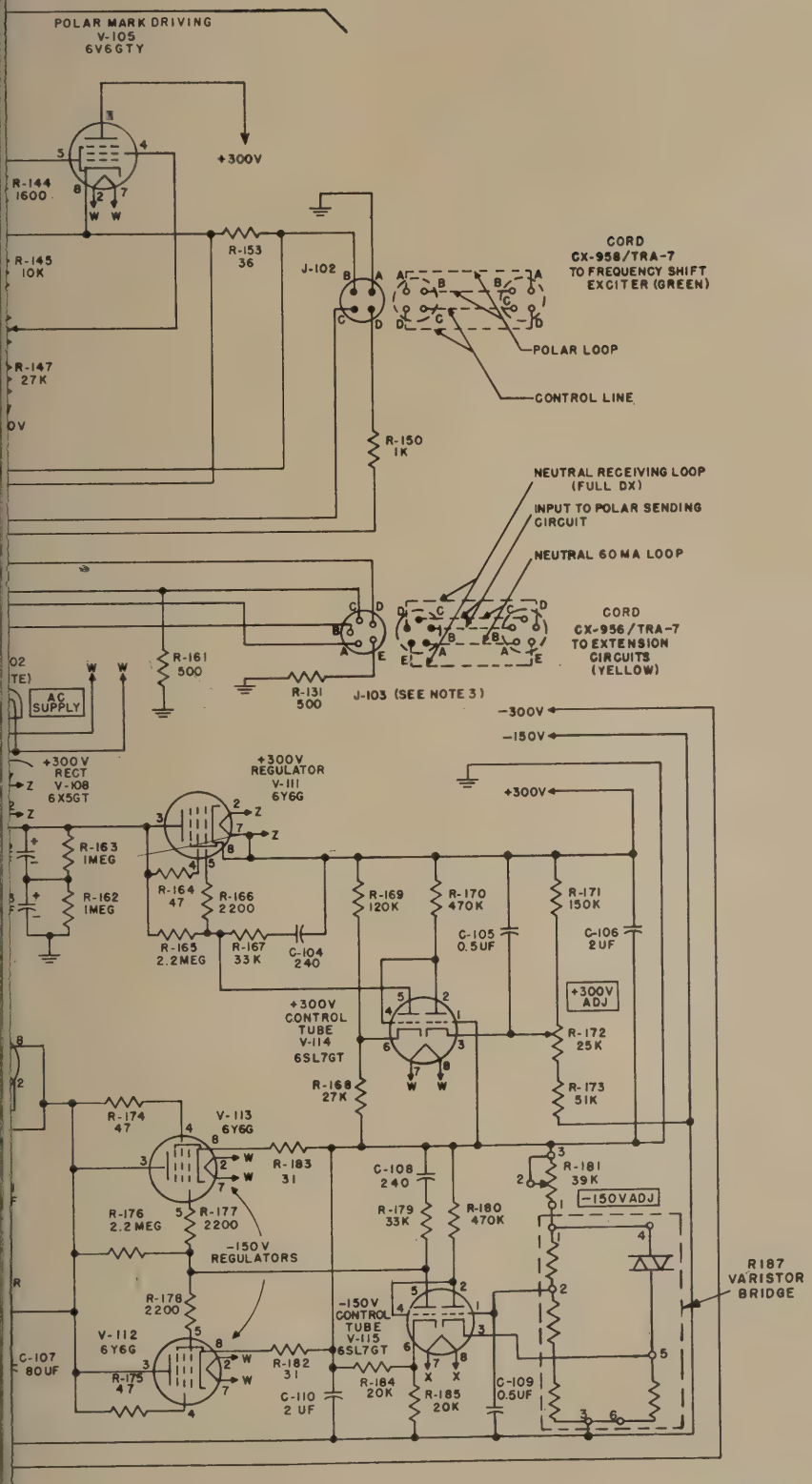
STANDARDS				
COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	–	–
BROWN	1	10	± 1	F
RED	2	100	± 2	G
ORANGE	3	1,000	± 3	–
YELLOW	4	10,000	± 4	–
GREEN	5	100,000	± 5	–
BLUE	6	1,000,000	± 6	–
VIOLET	7	10,000,000	± 7	–
GRAY	8	100,000,000	± 8	–
WHITE	9	1,000,000,000	± 9	–
GOLD	–	0.1	± 5	J
SILVER	–	0.01	±10	K
NO COLOR	–	–	±20	M

NOTES:

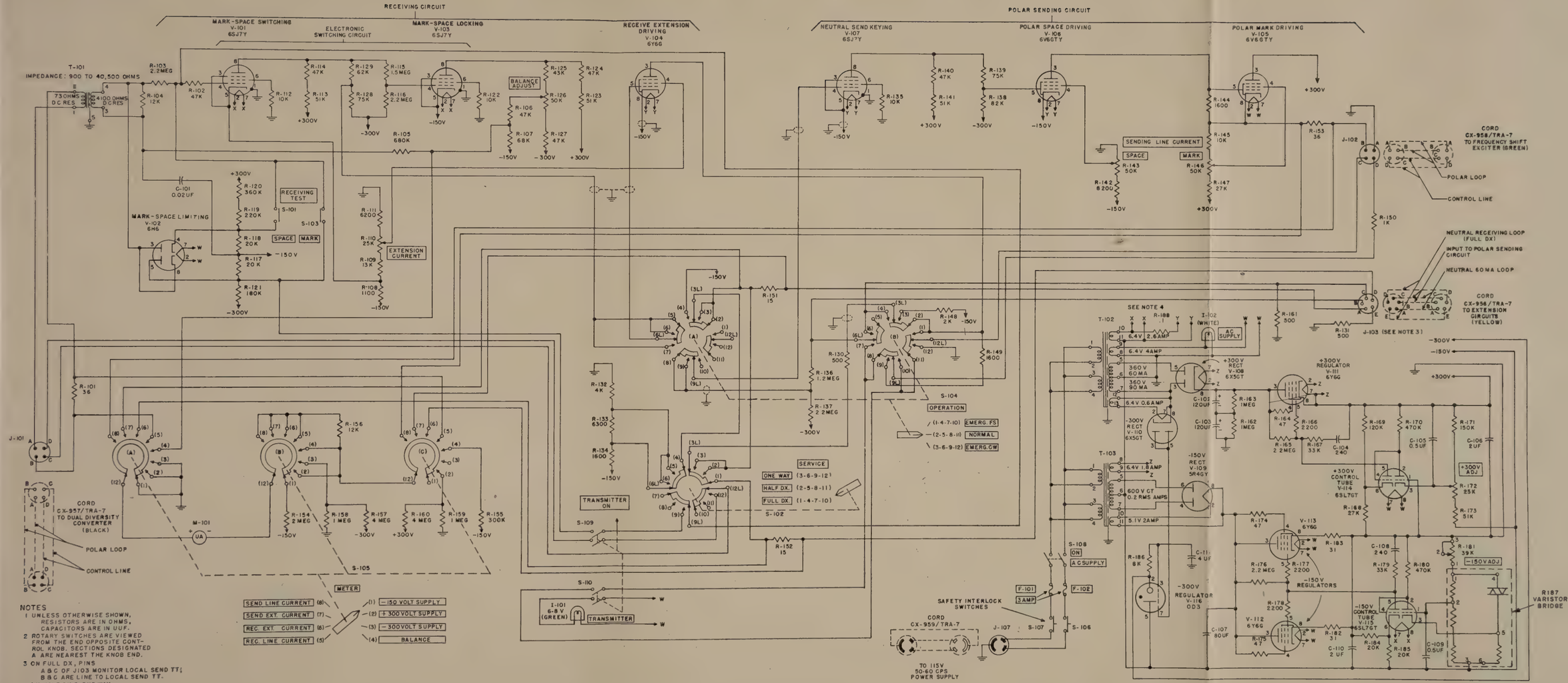
1. RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY-NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TM RC

Figure 32. Resistor color codes.


POLAR MARK DRIVING
V-105
6V6GTY
+300V
R-144
1600
R-145
10K
R-147
27K
R-153
36
J-102
CORD
CX-958/TRA-7
TO FREQUENCY SHIFT
EXCITER (GREEN)
POLAR LOOP
CONTROL LINE
R-150
1K
NEUTRAL RECEIVING LOOP
(FULL DX)
INPUT TO POLAR SENDING
CIRCUIT
NEUTRAL 60 MA LOOP
CORD
CX-956/TRA-7
TO EXTENSION
CIRCUITS
(YELLOW)
R-161
500
R-131
500
J-103 (SEE NOTE 3)
AC
SUPPLY
-300V
-150V
+300V
+300V
RECT
V-108
6X5GT
+300V
REGULATOR
V-111
6Y6G
R-163
1MEG
R-162
1MEG
R-164
47
R-166
2200
R-165
2.2MEG
R-167
33K
C-104
240
R-169
120K
R-170
470K
C-105
0.5UF
R-171
150K
C-106
2UF
+300V
ADJ
+300V
CONTROL
TUBE
V-114
6SL7GT
R-172
25K
R-173
51K
R-168
27K
R-174
47
V-113
6Y6G
R-183
31
C-108
240
R-181
39K
-150V ADJ
R-179
33K
R-180
470K
R-176
2.2MEG
R-177
2200
-150V
REGULATORS
R187
VARISTOR
BRIDGE
R-178
2200
-150V
CONTROL
TUBE
V-115
6SL7GT
V-112
6Y6G
R-182
31
C-107
80UF
R-175
47
C-110
2 UF
R-184
20K
R-185
20K
C-109
0.5UF

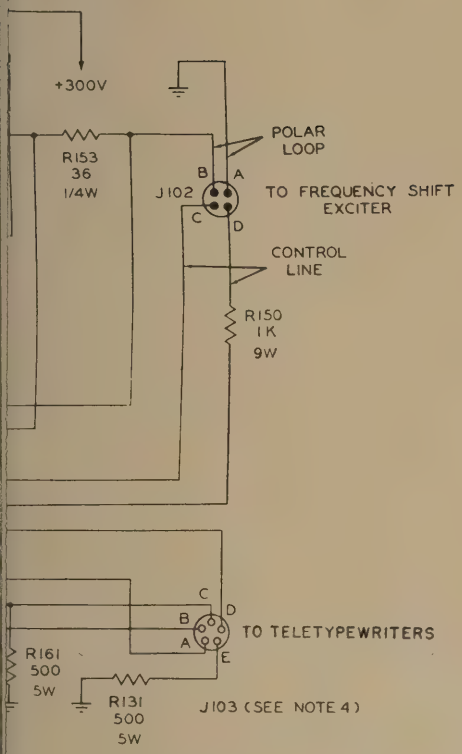
TM 262-23

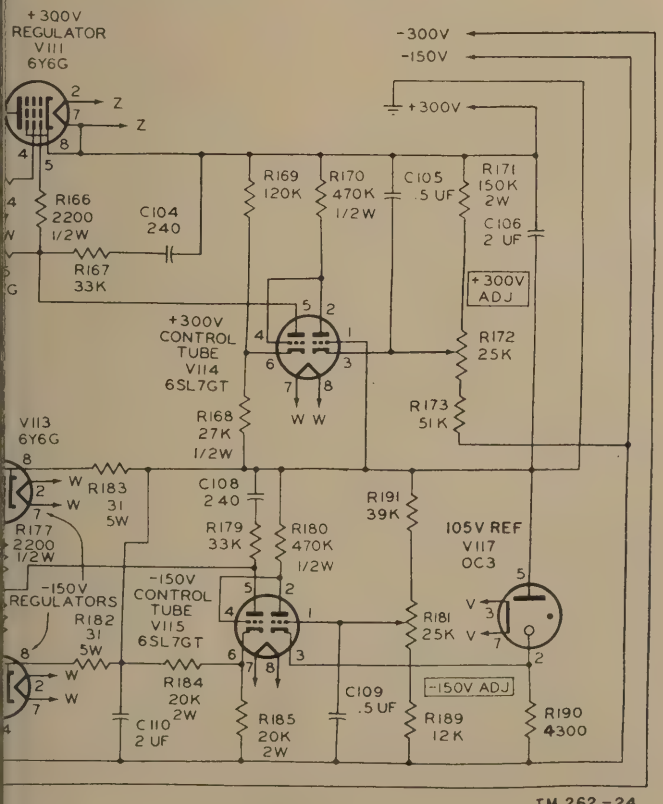


NOTES

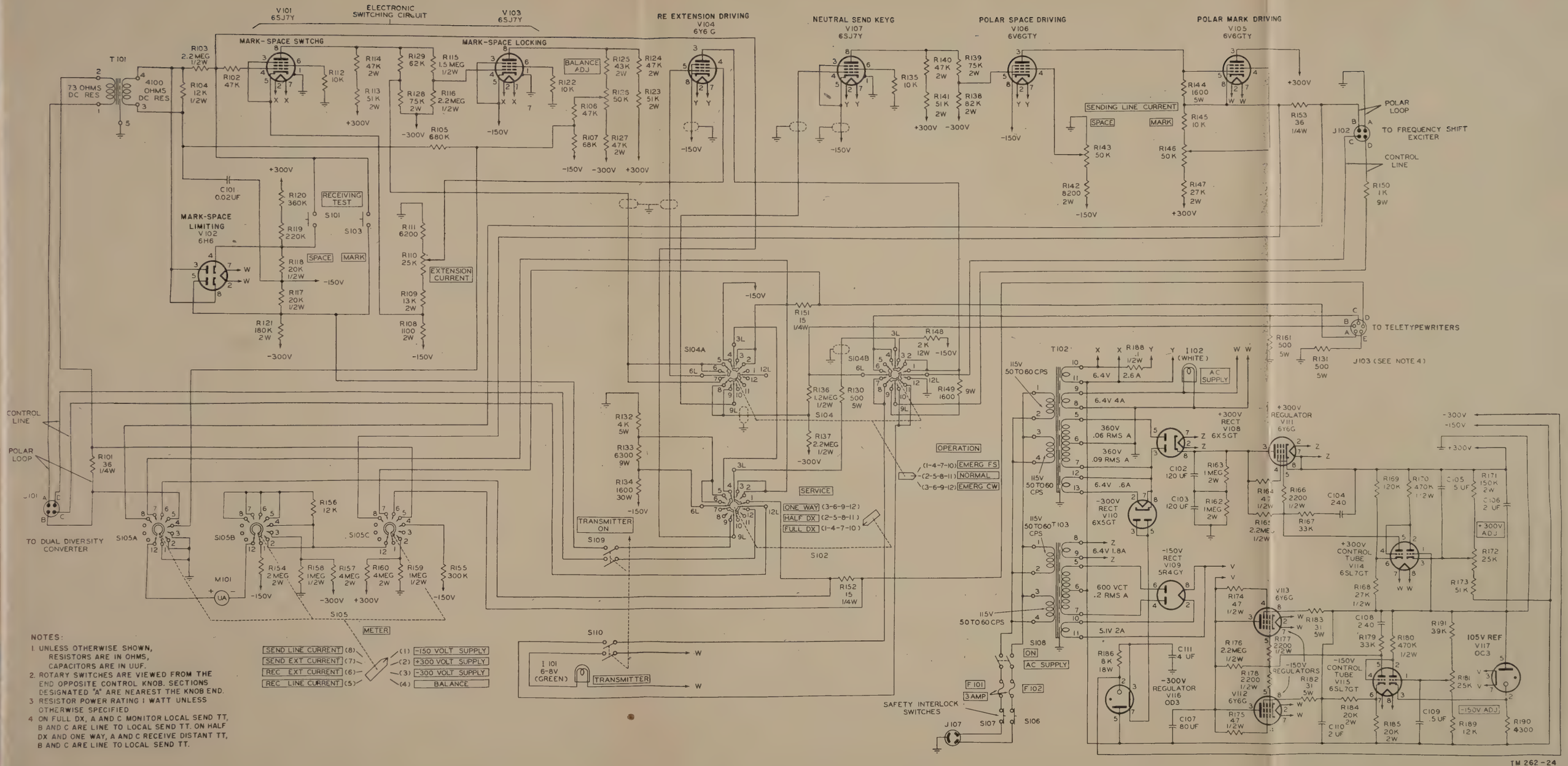
1 UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2 ROTARY SWITCHES ARE VIEWED FROM THE END OPPOSITE CONTROL KNOB. SECTIONS DESIGNATED A ARE NEAREST THE KNOB END.
3 ON FULL DX, PINS
A & C OF J103 MONITOR LOCAL SEND TT;
B & C ARE LINE TO LOCAL SEND TT.
ON HALF DX & ONE WAY,
A & C RECEIVE DISTANT TT;
B & C ARE LINE TO LOCAL SEND TT.
4 R188 NOT USED IN A MODEL.

Figure 33. Control Units C-292/TRA-7 and C-292A/TRA-7, schematic diagram.


+300V
R153
36
1/4W
POLAR
LOOP
B
A
J102
TO FREQUENCY SHIFT
EXCITER
C
D
CONTROL
LINE
R150
1K
9W
C
D
B
TO TELETYPEWRITERS
A
E
R161
500
5W
R131
500
5W
J103 (SEE NOTE 4)


+300V
REGULATOR
V111
6Y6G
-300V
-150V
+300V
Z
Z
R169
120K
R170
470K
1/2W
C105
.5 UF
R171
150K
2W
C106
2 UF
R166
2200
1/2W
C104
240
R167
33K
+300V
ADJ
+300V
CONTROL
TUBE
V114
6SL7GT
R172
25K
R168
27K
1/2W
W W
R173
51K
V113
6Y6G
R183
31
5W
C108
240
R191
39K
105V REF
V117
0C3
R177
2200
1/2W
R179
33K
R180
470K
1/2W
-150V
REGULATORS
R182
31
5W
-150V
CONTROL
TUBE
V115
6SL7GT
R181
25K
R184
20K
2W
C109
.5 UF
-150V ADJ
C110
2 UF
R185
20K
2W
R189
12K
R190
4300

TM 262-24

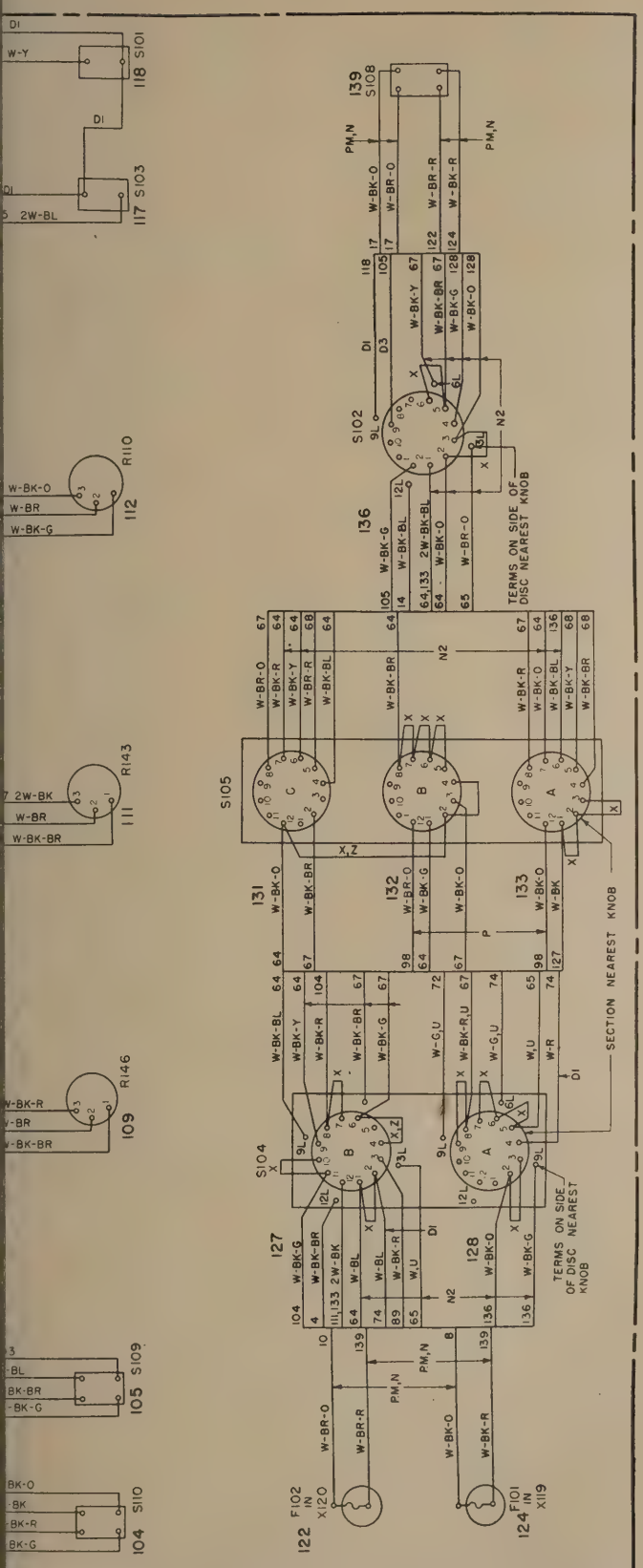


NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. ROTARY SWITCHES ARE VIEWED FROM THE END OPPOSITE CONTROL KNOB. SECTIONS DESIGNATED "A" ARE NEAREST THE KNOB END.
3. RESISTOR POWER RATING 1 WATT UNLESS OTHERWISE SPECIFIED
4. ON FULL DX, A AND C MONITOR LOCAL SEND TT, B AND C ARE LINE TO LOCAL SEND TT. ON HALF DX AND ONE WAY, A AND C RECEIVE DISTANT TT, B AND C ARE LINE TO LOCAL SEND TT.

TM 262-24

Figure 34. Control Unit C-292B/TRA-7, schematic diagram.



NOTES

1. ALL WIRING UNLESS OTHERWISE SPECIFIED SHALL BE 22GA STRANDED, RUN IN CABLE
2. "DI" WIRING SHALL BE W, 22GA STRANDED UNLESS OTHERWISE SPECIFIED, RUN DIRECTLY FROM, TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER WITH SUFFICIENT SLACK TO PREVENT BREAKING UNDER VIBRATION.
3. "D3" WIRING SHALL BE W, 22GA STRANDED UNLESS OTHERWISE SPECIFIED, RUN LOOSE AND DRESSED BACK AGAINST THE PANEL IN THE MOST CONVENIENT MANNER.
4. "M" DENOTES 20GA STANDED WIRE
5. "N" DENOTES LEADS RUN IN CABLE
6. "NI" DENOTES LEADS RUN IN CABLE
7. "N2" DENOTES LEADS RUN IN CABLE
8. "U" DENOTE 22GA STRANDED WIRE SHIELDED.
9. ALL STRAPS SHALL BE RUN AS SHORT AND DIRECT AS POSSIBLE.
10. ⊂⊃---DENOTES SHIELD CONNECTION
11. "X" DENOTES 20GA BARE TINNED STRAP WIRE.
12. "Z" DENOTES LEADS SHALL BE COVERED WITH IRV-O-LITE NO. 18 BLACK XTE-30 TUBING.
13. LEADS DESIGNATED "D3" CONNECTING TO TERMINALS OF E101, E102 AND E103 SHALL BE DRESSED BACK AGAINST PANEL BEFORE CABLE IS PUT IN PLACE
14. THESE LEADS SHALL BE RUN WITH "NI" LEADS BUT NOT SEWN IN CABLE FOR ELECTRICAL REASONS
15. "BI" DENOTES TERMINAL NEARER CHASSIS.
16. "P" DENOTES PAIR

W-G	SINGLES	22GA STRANDED WIRE, SHIELDED
W-BL		
W-BK-R		
W-BK-G		
W		
W-BR-O	PAIRS	20GA STRANDED WIRE
W-BK-O		
W-BR-R		
W-BK-R		
W		
W-BK		
W-BK-O	PAIRS	22GA STRANDED WIRE
W-BR-O		
W	SINGLES	
W-BL		
W-BK		
W-G		
W-Y		
W-BR		
W-R		
W-O		
W-BK-BR		
W-BK-R		
W-BK-O		
W-BK-Y		
W-BK-G		
W-BK-BL		
W-BR-R		
W-BR-O		

TL56302S

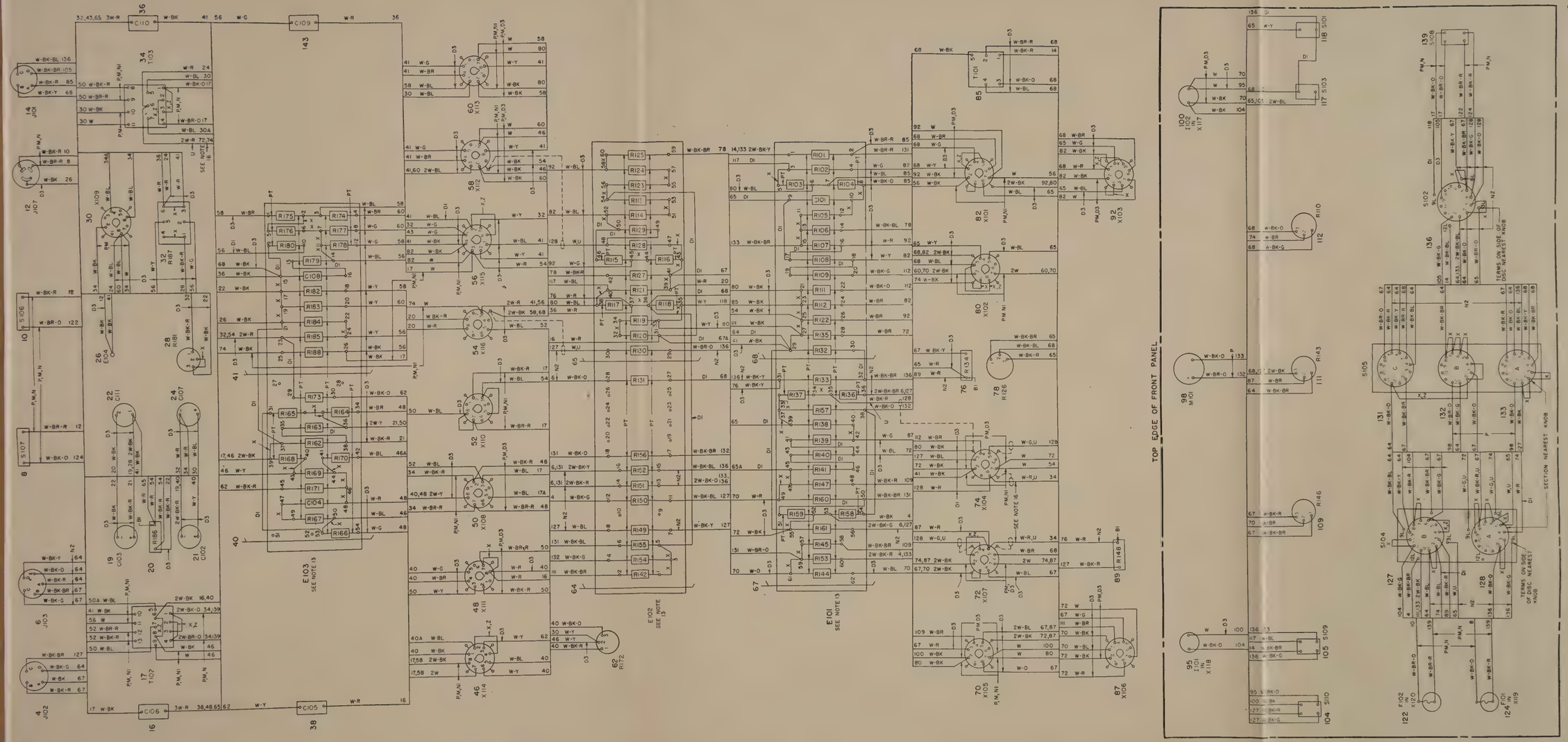


Figure 35. Control Unit C-292/TRA-7, wiring diagram.

J101
J107
S106
S107
J103
J102
X109
X113
X112
X115
X116
X110
X108
X111
X114
E103
E104
E102
E101
R187
R181
R186
R172
C110
C109
C111
C107
C103
C102
C108
C104
C106
C105
T103
T102
R175
R174
R176
R177
R180
R178
R179
R182
R183
R184
R185
R188
R173
R165
R164
R163
R162
R168
R170
R169
R171
R167
R166
R125
R124
R123
R113
R114
R129
R128
R115
R116
R127
R121
R117
R118
R119
R120
R130
R131
R156
R152
R151
R150
R149
R155
R154
R142
R101
R102
R103
R104
C101
R105
R106
R107
R108
R109
R111
R112
R122
R135
R132
R133
R137
R136
R157
R138
R139
R140
R141
R147
R160
R159
R158
R161
R145
R153
R144
1, W-BL, 40
2, W-BK, 15
3, W-BL, 16
4, W-R, 13
5, W-BK, 7
X107-TERM, 5
X104-TERM, 8
9, W-G
4, W-R
10, W-O
15, W-BL
5, W-G
4, W-BK
21, W-BK
6, W-O
20, W-BK
4, W-R
22, W-BK-R
23, W-R
31, W-BR
33, W-BK-O
39, W-BL
36, 39 (2) W-BK
40, W-O
33, W-BK-R
40, W-BL
36, W-BL
35, W-BL
24, W-BR
34, W-R
18, W-BK-O
38, W-O
30, W-BK-R
25, W-BL
27, 34 (2) W-BK
26, W-BL
54, R-BK
55, W-BK-R
58, W-BK
63, O-G
56, W-BK
(2) W-R, 24, 17
W-BK-R, 17
W-R, 2
(2) W-BK
12, W-BK
2, W-BL
1, W-BK
6, W-BL
1, W
3, W-BL
4, W-R
75, W-O-BL
81, 109, (2) 10-BK
60, W-BR
103, W-BR
85, O-G
73, O-BL
81, R-BK
101, W-BR
85, W-BK-O
105, W-BK
83, W-BK
56, RG-29/U
78, W-BK-O
74, R-BK
71, W-BK-R
37, W-BK
56, RG-29/U
87, W-BR
55, W-BK-R
76, W-O-G
37, 82, (2) W-BK-R
71, R-BK
71, W-BR
R-BK, 73
RG-29/U, 57
W-BK-R, 73
W-BL, 104
W-R, 23
W-O, 104
W-R, 34
R-BK, 79
W-BK-O, 74
O-BL, 53
O-G, 37
O-BL, 75
R-BK, 83
O-G, 77

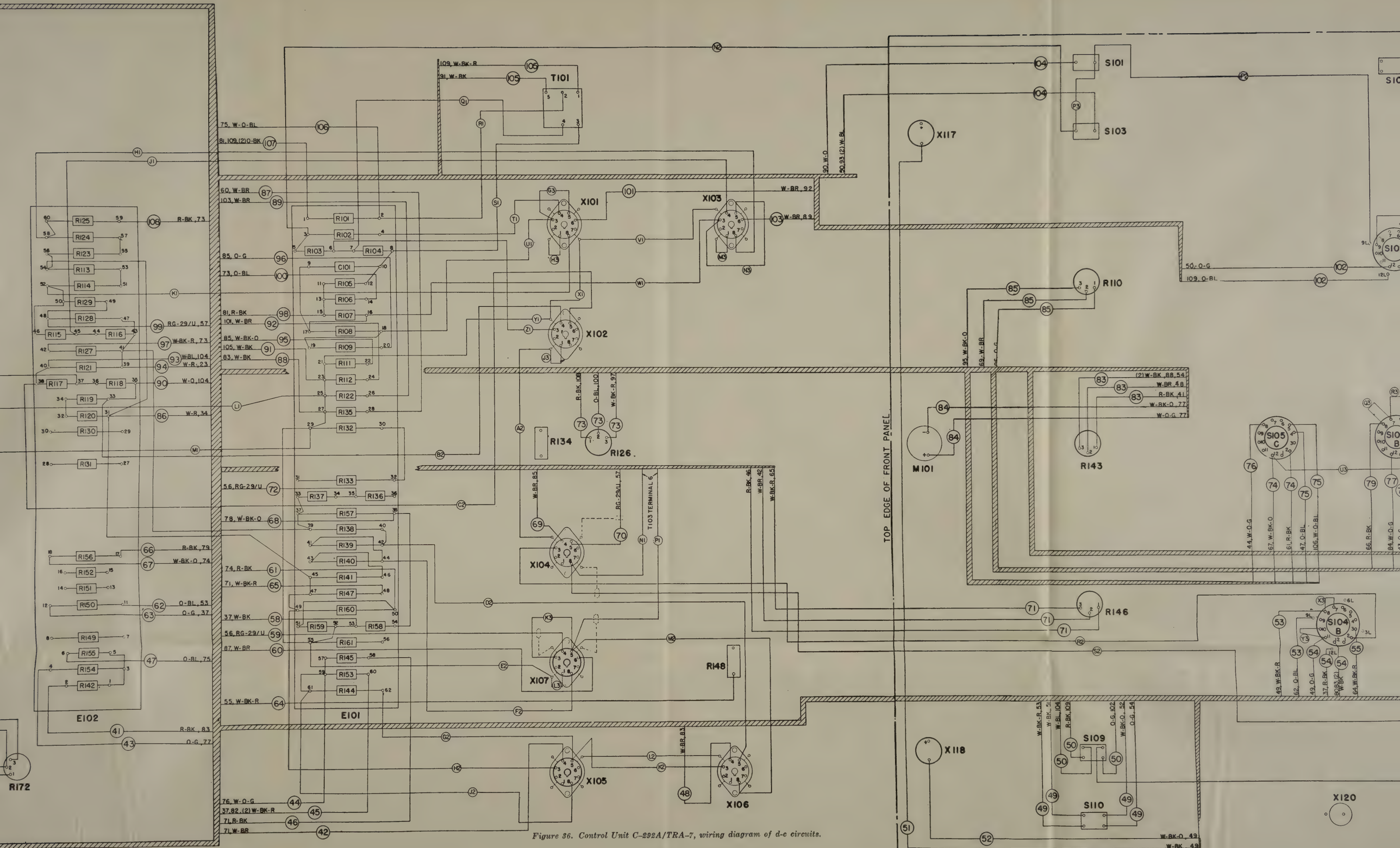
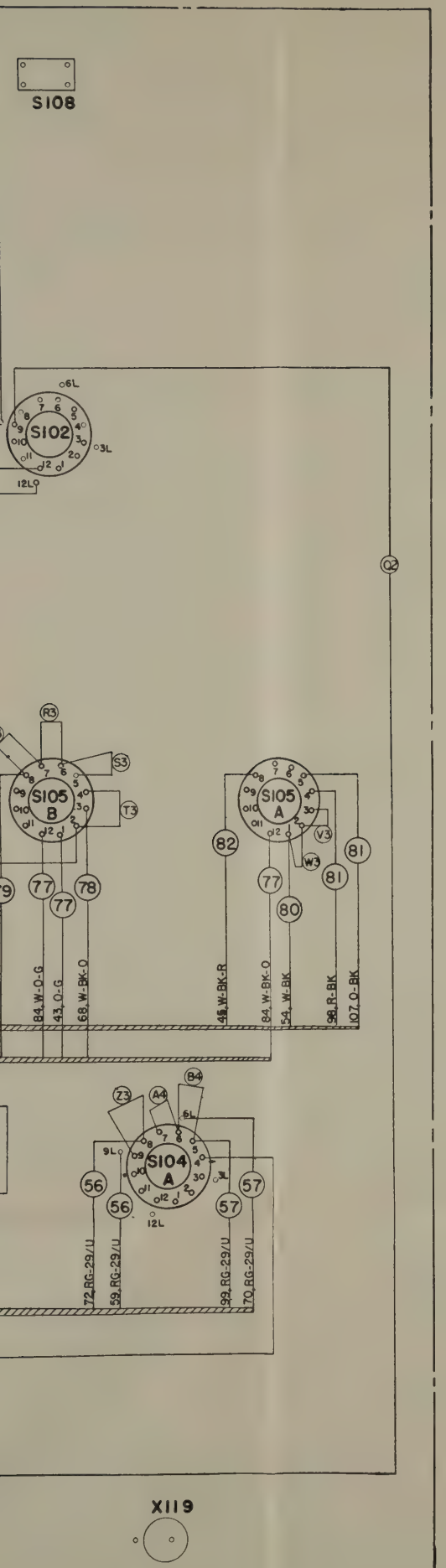


Figure 36. Control Unit C-292A/TRA-7, wiring diagram of d-c circuits.



CABLE WIRE TABLE

STATION	APPARATUS DESIGNATION	TERMINAL	DESCRIPTION
1	T103	10	W-BK (16 GA. WIRE)
"	"	11	W "
2	"	6	W-R (22 GA. WIRE)
"	"	7	W-BL "
3	"	5	W-BL "
4	C110	--	W-BK "
"	"	--	(3)W-R "
5	C109	--	W-G "
"	"	--	W-R "
6	X113	3	W-BL "
"	"	8	W-O "
7	E103	15	W-BK "
8	"	17	W-BK "
9	X115	1	W-G "
10	E103	20	W-O "
11	E102	37	W-R "
12	E103	21	W-BK "
13	R187	6	W-R "
14	X109	4	W-BL "
15	"	2	W-BK (16 GA. WIRE)
"	"	8	W (16GA) & W-BL (22 GA)
16	"	6	W-BL (22 GA. WIRE)
17	X116	2	W-R "
"	X116	3	W-BK-R "
18	E103	30	W-BK-O "
19	C107	NEG.	W-R "
20	E104	--	W-BK "
21	C111	--	W-BK "
22	R186	--	W-BK-R "
23	R186	--	W-R (2) "
24	E103	34	W-BR "
25	X108	5	W-BL "
26	"	3	W-BL "
27	E103	39	(2)W-BK "
28	"	42	W-BL "
29	"	43	W-O "
30	"	45	W-BK-R "
31	X111	4	W-BR "
"	"	8	W-R "
32	E103	50	W-BL "
33	R172	3	W-BK-O "
"	"	2	W-O "
"	"	1	W-BK-R "
34	C106	--	(3)W-R & W-BK "
35	T102	7	W-BL "
36	"	5	W-BL "
"	"	6	(2)W-BK "
37	J102	A	W-BK "
"	"	B	W-BK-R "
"	"	C	R-BK "
"	"	D	O-G "
38	C105	--	W-O "
"	"	--	W-R "
39	X114	1	W-BK "
"	"	2	W-BL "
40	"	5	W-BL "
"	"	6	W-O "
41	E102	2	R-BK "
42	X105	4	W-BR "
43	E102	4	O-G "
44	E101	59	W-O-G "
45	"	60	(2)W-BK-R "
46	"	58	R-BK "
47	E102	6	O-BL "
48	X106	4	W-BR "
49	S110	--	O-G "
"	"	--	W-BK-R "
"	"	--	W-BK "
"	"	--	W-BK-O "
50	S109	--	W-BL "
"	"	--	O-G "
"	"	--	R-BK "
51	X117	--	W-BK "
52	X118	--	W-BK-O "
53	S104B	8	W-BK-R "
"	"	9L	O-BL "
54	"	11	O-G "
"	"	12	(2)W-BK "
"	"	12L	R-BK "
55	"	3	W-BK-R "
56	S104A	8	RG-29/U (COAX'L CABLE)
"	"	9L	RG-29/U " "
57	"	5	RG-29/U " "
"	"	6L	RG-29/U " "
58	E101	53	W-BK (22GA. WIRE)
59	X107	4	RG-29/U (COAX'L CABLE)
60	"	6	W-BR (22GA. WIRE)
61	E101	50	R-BK "
62	E102	11	O-BL "
63	"	12	O-G "
64	R148	--	W-BK-R "
65	E101	48	W-BK-R "
66	E102	17	R-BK "
67	E102	18	W-BK-O "
68	E101	38	W-BK-O "
69	X104	4	W-BR "
70	"	5	RG-29/U (COAX'L CABLE)
71	R146	1	R-BK (22GA. WIRE)
"	"	2	W-BR "
"	"	3	W-BK-R "
72	E101	35	RG-29/U (COAX'L CABLE)
73	R126	3	W-BK-R (22GA. WIRE)
"	"	2	O-BL "
"	"	1	R-BK "
74	S105C	2	R-BK "
"	"	12	W-BK-O "
75	"	4	O-BL "
"	"	5	W-O-BL "
76	"	8	W-O-G "

STATION	APPARATUS DESIGNATION	TERMINAL	DESCRIPTION
77	S105B	1	O-G (22GA. WIRE)
"	"	12	W-O-G "
"	S105A	12	W-BK-O "
78	S105B	3	W-BK-O "
79	"	8	R-BK "
80	S105A	1	W-BK "
81	"	4	R-BK "
"	"	5	O-BK "
82	"	8	W-BK-R "
83	R143	1	R-BK "
"	"	2	W-BR "
"	"	3	(2)W-BK "
84	M101	POS.	W-O-G "
"	"	NEG.	W-BK-O "
85	R110	1	O-G "
"	"	2	W-BR "
"	"	3	W-BK-O "
86	E102	31	W-R "
87	E101	28	W-BR "
88	"	27	W-BK "
89	"	26	W-BR "
90	E102	35	W-O "
91	E101	23	W-BK "
92	"	24	W-BR "
93	E102	40	W-BL "
94	"	39	W-R "
95	E101	22	W-BK-O "
96	"	20	O-G "
97	E102	42	W-BK-R "
98	E101	15	R-BK "
99	E102	48	RG-29/U (COAX'L CABLE)
100	E101	14	O-BL (22GA WIRE)
101	X101	6	W-BR "
102	S102	12	O-G "
"	"	12L	O-BL "
103	X103	6	W-BR "
104	S101	--	W-O "
"	S103	--	(2)W-BL "
105	T101	5	W-BK "
"	"	1	W-BK-R "
106	E101	2	W-O-BL "
107	"	1	(2)O-BK "
108	E102	59	R-BK "
109	J101	A	W-BK-R "
"	"	B	O-BK "
"	"	C	O-BL "
"	"	D	R-BK "

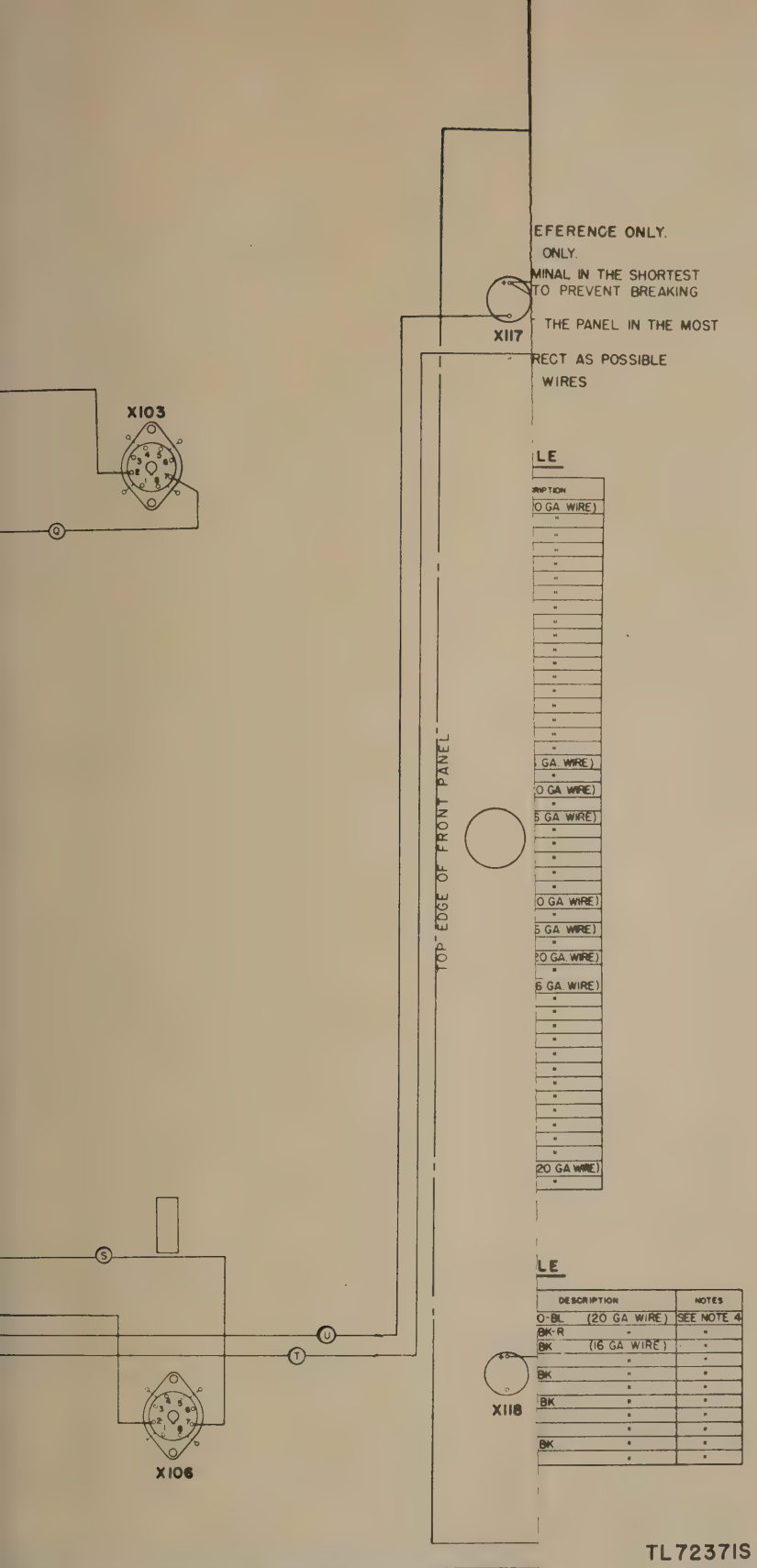
NOTES

1. STATION NUMBERS SHOWN ARE FOR REFERENCE ONLY.
2. JUMPER WIRE SYMBOLS ARE FOR REFERENCE ONLY
3. RUN WIRE DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER WITH SUFFICIENT SLACK TO PREVENT BREAKING UNDER VIBRATIONS
4. RUN WIRE LOOSE & DRESSED BACK AGAINST THE PANEL IN THE MOST CONVENIENT MANNER
5. ALL STRAPS SHALL BE RUN AS SHORT & DIRECT AS POSSIBLE.
6. ALL WIRES ARE STRANDED, EXCEPT BARE WIRES
7. THIS LEAD RUNS WITH CABLE, BUT NOT SEWN IN CABLE FOR ELECTRICAL REASONS.

JUMPER WIRE TABLE

WIRE SYMBOL	DESCRIPTION	NOTES
A	W-BK (22GA WIRE)	SEE NOTE 4
B	W-BL "	" 4
C	W-BK-R "	" "
D	W-R "	" "
E	W-R "	" "
F	W-BK "	" "
G	W-BK "	" "
H	W-BK-R "	" "
J	W-BK-R "	" "
K	W-O "	" "
L	W-BK-R "	" "
M	W-O "	" "
N	W-BR "	" "
P	W-G "	" "
Q	W-BR "	" "
R	W-G "	" "
S	W-BL "	" "
T	W-GR "	" "
U	W-BL "	" "
V	W-BL "	SEE NOTE 3
W	W-O "	SEE NOTE 4
X	W-BK "	" "
Y	W-BL "	" "
Z	W-O "	" "
A1	W-BL "	" "
B1	W-BL "	" "
C1	W-O "	" "
D1	W-R "	" "
E1	W-G "	" "
F1	W-O "	" "
G1	W-O "	" "
H1	W-BL "	" "
J1	W-G "	" "
K1	W-BL "	" "
L1	W-BK "	" "
M1	W-BK "	" "
N1	RG-29/U (COAXIAL CABLE)	SEE NOTE 7
P1	" "	" "
Q1	W-BL (22GA WIRE)	SEE NOTE 4
R1	W-O-BL "	" "
S1	W-BK-O "	" "
T1	W-G "	" "
U1	W-O "	" "
V1	W-BK "	" "
W1	W-R "	" "

WIRE SYMBOL	DESCRIPTION	NOTES
X1	W-BK (22GA WIRE)	SEE NOTE 4
Y1	W-BK "	" "
Z1	W-BL "	" "
A2	W-BK "	" "
B2	W-O "	" "
C2	W-R "	" "
D2	W-G "	" "
E2	W-BK "	" "
F2	W-BL "	" "
G2	W-BL "	" "
H2	W-R "	" "
J2	W-O "	" "
K2	W-BL "	" "
L2	W-K "	" "
M2	W-R "	" "
N2	W-S "	SEE NOTE 3
P2	W-BL "	" "
Q2	W-O "	SEE NOTE 4
R2	W-BL "	SEE NOTE 3
S2	W-F "	" "
A3	BARE (20GA TINNED STRAP WIRE)	SEE NOTE 5
B3	" " "	" "
C3	" " "	" "
D3	W-BL (22GA WIRE)	SEE NOTE 3
E3	W-BL "	" "
F3	W-BL "	" "
G3	W-O "	" "
H3	BARE (20GA TINNED STRAP WIRE)	SEE NOTE 5
J3	" " "	" "
K3	W-R (22GA WIRE)	SEE NOTE 3
L3	BARE (20GA TINNED STRAP WIRE)	SEE NOTE 5
M3	" " "	" "
N3	W-R (22GA WIRE)	SEE NOTE 3
P3	W-G "	" "
Q3	BARE (20GA TINNED STRAP WIRE)	SEE NOTE 5
R3	" " "	" "
S3	" " "	" "
T3	" " "	" "
U3	W-BK-O (22GA WIRE)	SEE NOTE 3
V3	BARE (20GA TINNED STRAP WIRE)	SEE NOTE 5
W3	" " "	" "
X3	" " "	" "
Y3	" " "	" "
Z3	" " "	" "
A4	" " "	" "
B4	" " "	" "


EFERENCE ONLY.
ONLY.
MINAL IN THE SHORTEST
TO PREVENT BREAKING
THE PANEL IN THE MOST
RECT AS POSSIBLE
WIRES
X117
X103
LE
RIPTION
O GA WIRE)
GA WIRE)
O GA WIRE)
5 GA WIRE)
O GA WIRE)
5 GA WIRE)
O GA WIRE)
6 GA WIRE)
20 GA WIRE)
TOP EDGE OF FRONT PANEL
LE
DESCRIPTION
NOTES
O-BL (20 GA WIRE)
SEE NOTE 4
BK-R
BK (16 GA WIRE)
BK
BK
BK
X118
X106
S
T
U

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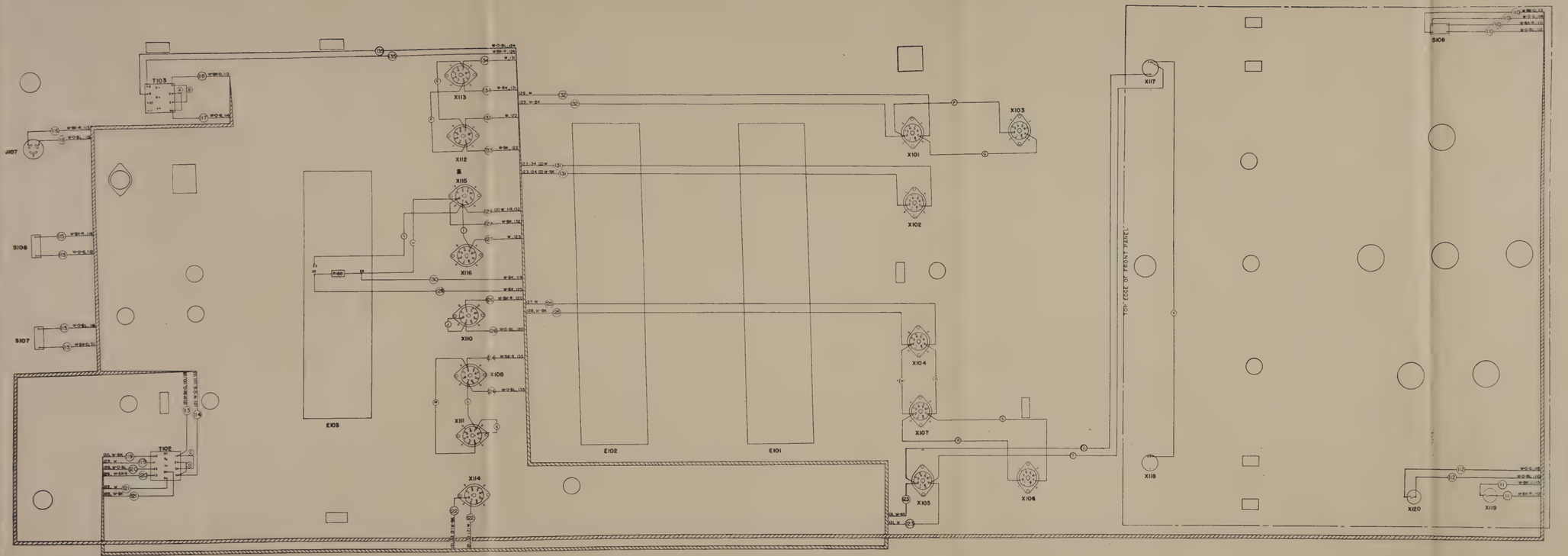

NOTES

1. STATION NUMBERS SHOWN ARE FOR REFERENCE ONLY
2. JUMPER WIRE SYMBOLS ARE FOR REFERENCE ONLY
3. RUN WIRE DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER WITH SUFFICIENT SLACK TO PREVENT BREAKING UNDER VIBRATION.
4. RUN WIRE LOOSE & DRESSED BACK AGAINST THE PANEL IN THE MOST CONVENIENT MANNER.
5. ALL STRAPS SHALL BE RUN AS SHORT & DIRECT AS POSSIBLE
6. ALL WIRES ARE STRANDED, EXCEPT BARE WIRES

CABLE WIRE TABLE

STATION	SYMBOL OF TERMINATION	TO PANEL	DESCRIPTION
1	X108	1	W-BL (20 GA WIRE)
"	"	"	W-BR
"	"	"	W-O
"	"	"	W-BR-O
11	X119	"	W-BR
"	"	"	W-BR-O
12	X120	"	W-O
"	"	"	W-O-BL
13	TB02	"	W-BR-O
14	"	4	22 W-O-G
15	S106	"	W-O-G
"	"	"	W-BR-BL
"	S107	"	W-BR-BL
"	"	"	W-O-BL
16	J107	"	W-O-BL
"	"	"	W-BR-BL
17	T103	4	W-O-G
18	"	"	W-BR-G
19	T102	10	W-BR (22 GA WIRE)
"	"	11	W
120	"	12	W-O-BL (20 GA WIRE)
"	"	"	W-BR-BL
121	"	8	W-BR (18 GA WIRE)
"	"	"	W
122	X104	3	22 W
"	"	8	22 W-BK
123	X105	3	W-BR
"	"	2	W
124	X108	2	W-BR (20 GA WIRE)
"	"	7	W-O-BL
125	X104	2	W-BR (18 GA WIRE)
"	"	"	W
126	X110	7	W-O-BL (20 GA WIRE)
"	"	2	W-BR-BL
127	X116	"	W (20 GA WIRE)
128	X103	23	W-BR
129	X114	3	W-BR
"	"	8	W-BR
130	X103	24	W-BR
131	X102	3	W-BR-BK
"	"	2	W-BR
132	X101	2	W-BR
"	"	3	W
133	X102	2	W-BR
"	"	3	W
134	X113	3	W-BR
"	"	3	W
135	T V1	8	W-BR-W (20 GA WIRE)
"	"	3	W-O-BL

JUMPER WIRE TABLE

JUMPER LABEL	DESCRIPTION	NOTES
A	W-O-G (20 GA WIRE)	SEE NOTE 3
B	W-BR-G	"
C	W	"
D	W-O-G (6 GA WIRE)	SEE NOTE 4
E	W-BK	"
F	W-BK (20 GA WIRE)	"
G	W-BL (16 GA WIRE)	"
H	W-BL (20 GA WIRE)	"
I	W-R (20 GA WIRE)	"
J	BARE (20 GA TINNED COPPER WIRE)	SEE NOTE 5
K		

JUMPER LABEL	DESCRIPTION	NOTES
L	W-BL (20 GA WIRE)	SEE NOTE 4
M	W-BR-R	"
N	W-BR (10 GA WIRE)	"
O	W	"
P	W-BR	"
Q	W-O-BL	"
R	W-BR-BK	"
S	W	"
T	W-BR	"
U	W	"
V	W-BR	"

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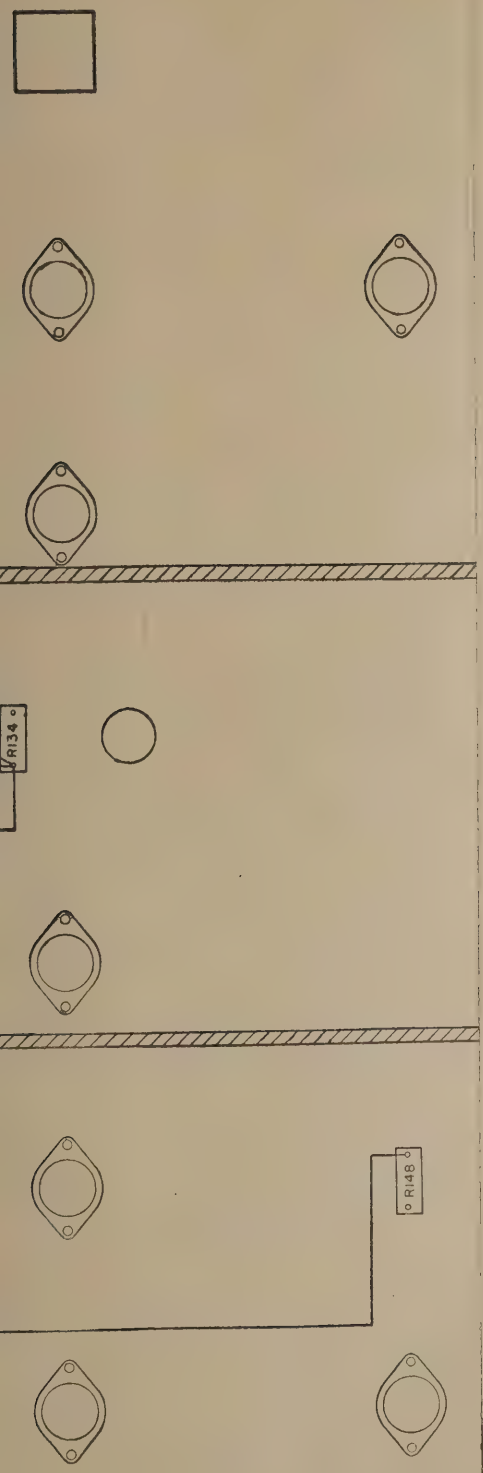
Figure 87. Control Unit C-892A/TRA-7, wiring diagram of filament and a-c circuits.



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4. RUN WIRE LOOSE & DRESSED BACK AGAINST THE PANEL IN THE MOST CONVENIENT MANNER.
5. ALL STRAPS SHALL BE RUN AS SHORT & DIRECT AS POSSIBLE.
6. ALL WIRES ARE STRANDED, EXCEPT BARE WIRES.
7. THIS LEAD RUNS WITH CABLE, BUT NOT SEWN IN CABLE FOR ELECTRICAL REASONS.

CABLE WIRE TABLE

STATION	APPARATUS DESIGNATION	TERMINAL	DESCRIPTION	
136	J103	A	W-BK-R (22 GA. WIRE)	
"	"	B	BK-R "	
"	"	C	O-G "	
"	"	D	O-BK "	
"	"	E	W-BK-O "	
137	E101	56	(2) O-G "	
138	E102	8	W-BL "	
139	"	7	O-BK "	
140	"	14	(2) W-BK-R "	
"	"	16	(2) O-BK "	
141	"	13	(2) W-BK-O "	
"	"	15	O-BL "	
142	R148	—	W-R "	
143	S104B	9	O-BK "	
144	"	6	O-G "	
"	"	6L	R-BK "	
145	S104A	2	W-BK-O "	
"	"	3L	O-G "	
"	S104B	1	W-BL "	
146	"	3L	RG-29/U (COAX. CABLE)	SEE NOTE 7
147	R134	—	W-R (22 GA. WIRE)	
148	E101	36	(2) R-BK "	
149	E102	28	W-BK-O "	
"	E101	32	R-BK "	
150	"	31	O-BK "	
151	E102	29	W-O-G "	
152	"	30	RG-29/U (COAX. CABLE)	SEE NOTE 7
153	S105C	6	O-BK (22 GA. WIRE)	
"	"	7	W-BK-R "	
"	S105A	6	O-BL "	
"	"	7	W-BK-O "	
154	S102	1	(2) O-BL "	
"	"	2	W-BK-O "	
"	"	3L	W-O-G "	
155	"	3	W-BK-O "	
"	"	4	O-G "	
"	"	5	R-BK "	
"	"	6L	O-BK "	

JUMPER WIRE TABLE

WIRE SYMBOL	DESCRIPTION	NOTES
A	W-R (22 GA. WIRE)	SEE NOTE 4
B	O-BK "	"
C	BARE (20 GA. TINNED STRAP WIRE)	SEE NOTE 5
D	" "	"
E	O-G (22 GA. WIRE)	SEE NOTE 3
F	BARE (20 GA. TINNED STRAP WIRE)	SEE NOTE 5
G	" "	"

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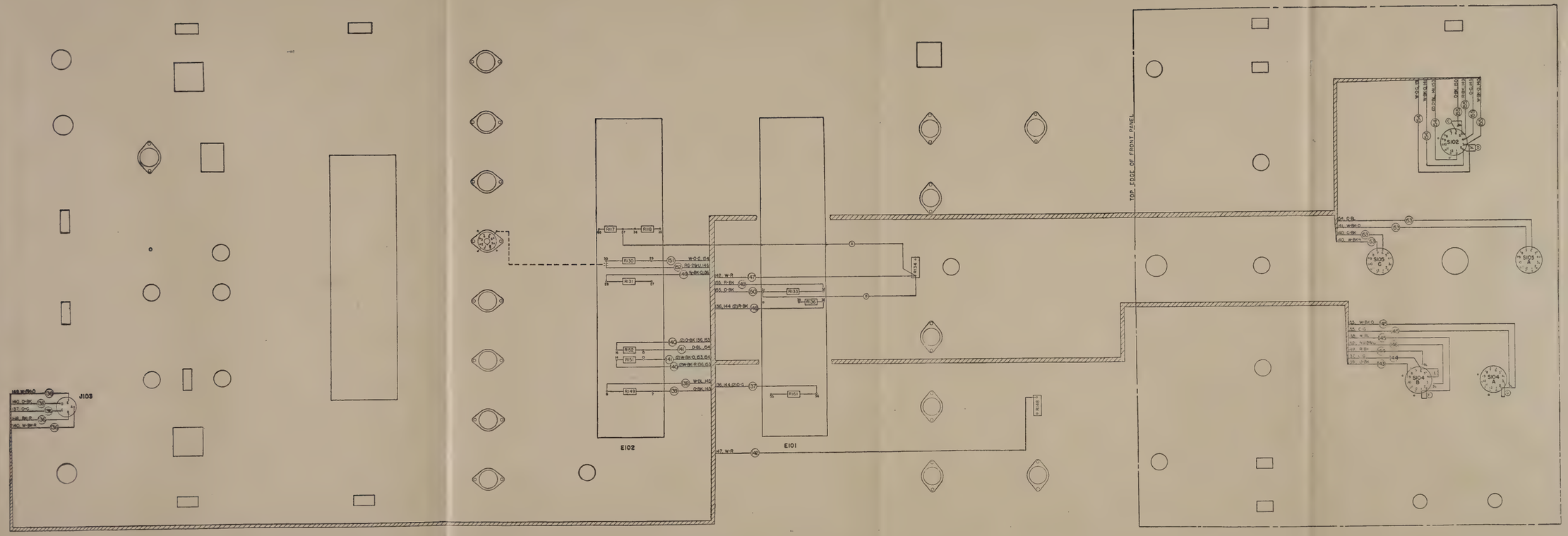

Figure 38. Control Unit C-892A/TRA-7, control circuit.

NOTES

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7. THIS LEAD RUNS WITH CABLE, BUT NOT SEWN IN CABLE FOR ELECTRICAL REASONS

CABLE WIRE TABLE

STATION	APPARATUS DESIGNATION	TERMINAL	DESCRIPTION	
136	J103	A	W-BK-R (22 GA WIRE)	
"	"	B	BK-R	"
"	"	C	O-G	"
"	"	D	O-BK	"
"	"	E	W-BK-O	"
137	E101	68	(21) O-G	"
138	E102	B	W-BL	"
139	"	7	O-BK	"
140	"	16	(21) W-BK-R	"
"	"	18	(21) O-BK	"
141	"	13	(21) W-BK-O	"
"	"	15	O-BL	"
142	R-148	—	W-R	"
143	S-048	9	O-BK	"
144	"	6	O-G	"
"	"	6L	R-BK	"
145	S-044	2	W-BK-O	"
"	"	3L	O-G	"
	S-048	1	W-BL	
146	"	3L	RG-28/U (COAX CABLE)	SEE NOTE 7
147	R-134	—	W-R (22 GA WIRE)	
148	E-101	36	(21) R-BK	"
149	E-102	28	W-BK-O	"
"	E-101	32	R-BK	"
150	"	31	O-BK	"
151	E-102	29	W-O-G	"
152	"	30	RG-28/U (COAX CABLE)	SEE NOTE 7
153	S-05C	8	O-BK (22 GA WIRE)	
"	"	5	W-BK-R	"
"	S-054	6	O-BL	"
"	"	7	W-BK-O	"
154	S-02	1	(21) O-BL	"
"	"	2	W-BK-O	"
"	"	3L	W-O-G	"
155	"	3	W-BK-O	"
"	"	4	O-G	"
"	"	5	R-BK	"
"	"	6L	O-BK	"

JUMPER WIRE TABLE

W-PR SET NO.	DESCRIPTION	NOTES
A	W-R (22 GA WIRE)	SEE NOTE 4
B	O-BK "	"
C	BARE (20 GA TINNED STRAP WIRE)	SEE NOTE 5
D	" "	"
E	O-G (22 GA WIRE)	SEE NOTE 5
F	BARE (20 GA TINNED STRAP WIRE)	SEE NOTE 5
G	"	"

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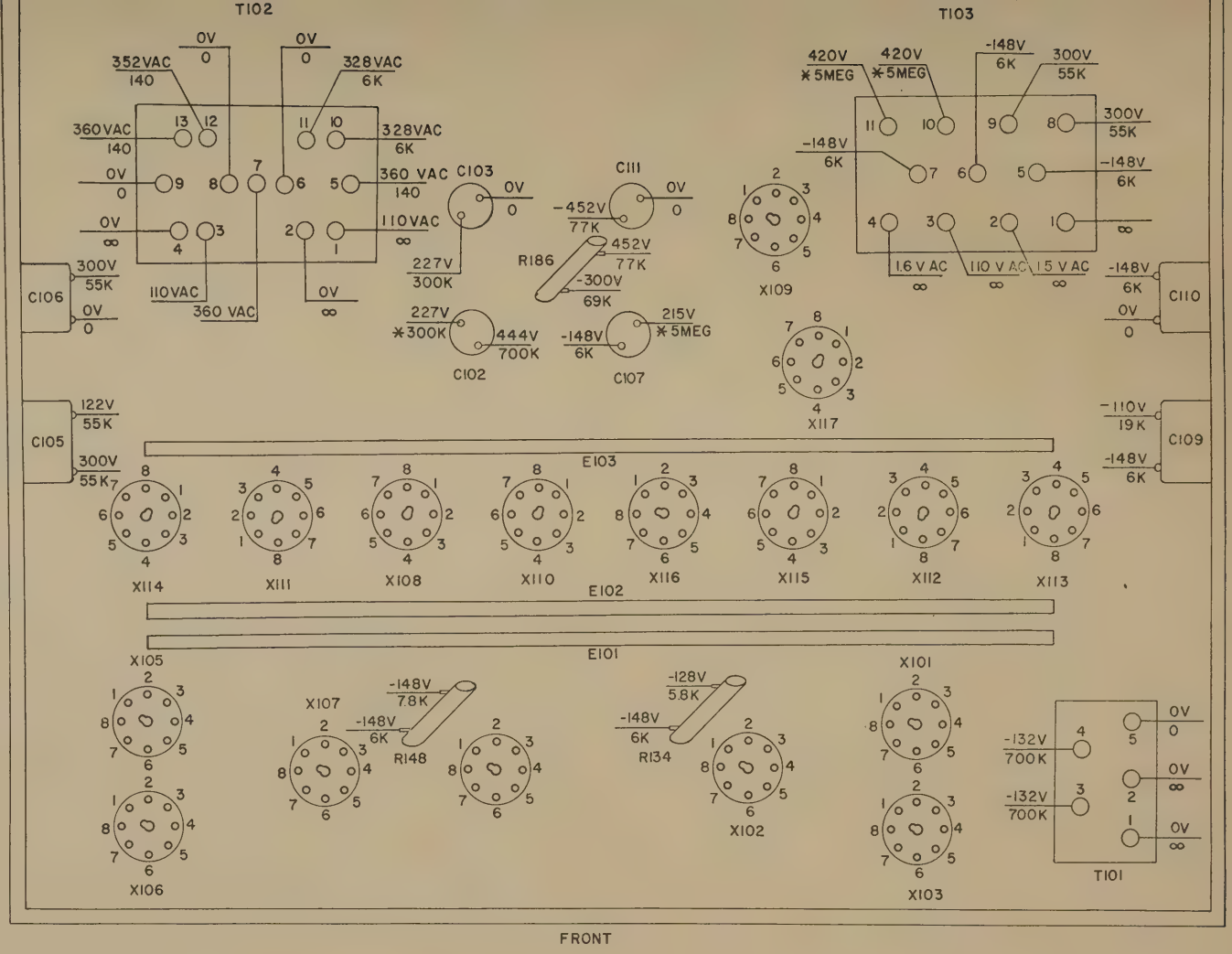

NOTES:

1 K=1000 OHMS

2 *SOME TIME IS REQUIRED FOR THE NEEDLE TO COME TO REST ON THESE MEASUREMENTS

TM 262-38

Figure 39. Control Unit C 292B/TRA-7, resistances and voltages to ground of capacitors and transformers.

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